CURRENT AH-1 EVOLUTION PLAN

290	100	98	107
MODERNIZED AH-1S	PRODUCTION AH-1S	UP-GUN AH-1S	MODERNIZED AH-1S
Modified from existing AH-1G's	Low glint canopy New instruments New blade at #67 Radar warning CONUS Nav radios RAM improvements	20mm cannon Stores management 10,000 volt alternator	Laser rangefinder Laser detector New fire control I R jammer New I R suppressor Doppler Nav New transponder and secure voice

Figure 1

MODERNIZED

FIELDING THE AH-1S Cobra TOW antiarmor attack helicopter to operational units has been a tremendous success. The combination of proven technology, coordinated management and professional introduction speaks for itself. This new helicopter has been demonstrated to several European countries and at the Paris Air Show. In each case, its capabilities have generated enthusiastic aviator response and positive command interest.

The first ship of the 297 new production aircraft was delivered to the Army in March 1977, with final delivery scheduled for February 1981. As these new helicopters are delivered from the production line, they will be issued initially to FORSCOM CONUS units. This fielding began in August 1977 at Fort Bragg, NC with the assignment of aircraft to the 82d Airborne Division.

This article, the first of a three-part series, addresses the scope of the Cobra program and highlights the improvements that have been or will be accomplished within the next few years to modernize fully the AH-1S Cobra TOW antiarmor attack helicopter. The second and third parts of this series will cover the new turret and weapons programs and the fire control, aircraft survivability and laser rangefinder/tracker programs, respectively.

MODERNIZATION ACCOMPLISHED IN PHASES: Improvements to the AH-1S new production aircraft will be accomplished through phased product improvement programs. The configuration changes and phasing for the Cobra fleet evolution to modernized AH-1S is summarized in figure 1. The first 66 aircraft produced will feature a new canopy and cockpit, a new T703 engine, uprated transmission plus im-

GLOSSARY

ADF	automatic direction finder
AM	amplitude modulation
CONUS	Continental United States
ECU	environmental control unit
FM	frequency modulated
FORSCOM	Forces Command
HSI	horizontal situation indicator
IFR	instrument flight rules
ILS	instrument landing system
KHz	kilohertz
MHz	megahertz
NOE	nap-of-the-earth
NVG	night vision goggles
RAM	reliability, availability and maintainability
SLAE	standard lightweight avionics equipment
TOW	tube-launched, optically-tracked, wire-guided
TSU	telescopic sight unit
UHF	ultra high frequency
VHF	very high frequency
VOR	VHF omnidirectional range
VSI	vertical situation indicator

Figure 2 — AH-1S new production Cobra with IR paint

COBRA

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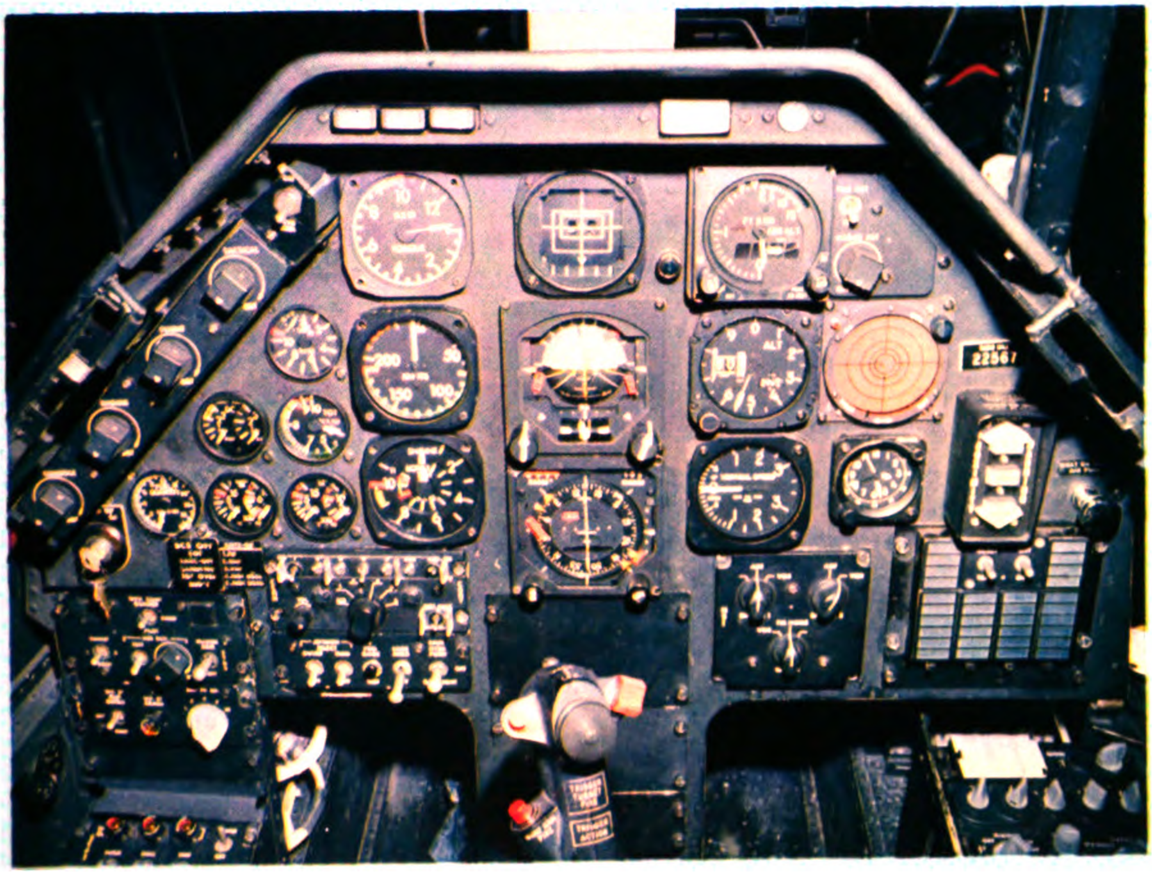


Figure 3 — pilot station instrument panel and consoles

proved survivability design features and reliability, availability and maintainability (RAM) characteristics.

Figure 2 is the new production AH-1S. Beginning in April 1978 with the 67th production helicopter, a new improved main rotor blade developed by Kaman Aerospace Corporation will be installed. A new wing stores (2.75 mm rocket) management subsystem and a universal turret capable of accepting 20 or 30 mm weapons will be cut into the production line beginning with the 101st aircraft, scheduled to be delivered in September 1978. A new fire control subsystem consisting of laser rangefinder, ballistic computer, low airspeed sensor and a heads-up display will be installed on the 199th aircraft which is scheduled to be delivered in November 1979.

CANOPY AND INSTRUMENT PANELS: The production AH-1S model has a new outward appearance with its nearly flat canopy. This canopy has seven planes of viewing surfaces designed to decrease the glint signature and reduce the probability of visual detection during NOE flight. Another advantage of the new canopy is additional headroom for the pilot's visibility in NOE flight.

The cockpits of both the pilot and copilot/gunner have been redesigned with a new instrument panel to provide for crew efficiency during NOE and IFR flight. Figure 3 is the pilot's new instrument panel. The major improvement in this panel is the grouping and the size of the instruments. The torque meter, pilot steering indicator and radar altimeter are the primary tactical instruments used by the pilot to accomplish the antiarmor mission. These three instruments are located in the center of the panel, under the glare shield, and are 3-inch diameter in size. They facilitiate NOE flight and maneuvering of the helicopter into position for firing the TOW missile and keeping it within maneuver limits until missile impact.

Flight instruments are arranged in a standard IFR "T" configuration comprised of 4-inch diameter VSI and HSI grouped with 3-inch airspeed, altitude and vertical speed indicators. The number of engine instruments is reduced by using dual scale 2-inch instruments where possible. All instruments are equipped with wedge glass to distribute red lighting evenly over the instrument. The dial range markings, numerals and letters are designed to be readable under extremely low light red illumination and when using night vision goggles.

The instrument lighting switches are located on the left side of the panel and provide selective illumination of related instruments for engine, flight, tactical and console groups. The light intensity is rheostat controllable and a toggle switch is provided to the pilot and copilot for returning lighting to the panel if the NVG lights malfunction.

NEW INSTRUMENT CAPABILITY: In addition to the grouping of the instruments on the panel, there are several new instruments that have been added to improve the effectiveness of the AH-1S helicopter. The *radar altimeter*, one of the three primary tactical instruments, provides the crew the ability to fly safely at NOE during periods of poor visibility. The APR-39 radar warning receiver — a survivability improvement — is simple and lightweight, capable of being used during low level and NOE operations. This device provides the pilot sufficient warning in time to take evasive action before receiving fire from radar directed enemy antiaircraft weapons. This warning is provided through an audio and a visual display in the form of a strobe line on a cathode ray tube.

HSI and VSI. These two instruments provide a system that makes precision IFR flight and ILS, VOR and ADF approaches as natural in helicopters as it has become in fixed wing aircraft. Growth capability has been incorporated for future navigation systems such as doppler and flight director computers.

Copilot Panel. Figure 4 on the front cover shows the arrangement of the instruments used by the copilot/gunner. These flight instruments also are grouped in a standard IFR "T" configuration located on the right side of the panel and are all 3-inch diameter in size. A standby magnetic compass is mounted above and on the right side on the copilot/gunner panel glare shield. All of these instruments are marked and lighted as the pilot's. The eyepiece for the TSU is in the center of the cockpit and is used by the copilot to locate the target and guide the missile on to the target during the firing sequence.

An ECU has been redesigned for the AH-1S. The distribution ducts and plumbing for ventilating and environmentally conditioning air within the crew compartments have been modified and rerouted to adapt to the new cockpit configuration.

IMPROVED MAIN ROTOR BLADE: A new composite main rotor blade has been developed by Kaman Aerospace Corporation for use on the AH-1S. It has been designed to be used on the existing airframe without modifications to the AH-1S or its rotor system. It is scheduled to be installed in April 1978 on the 67th new production helicopter and will provide improved flight performance, survivability features and RAM, while reducing the radar cross section and acoustic detectability signatures.

Figure 5 shows the test blade installation on an existing AH-1G model. The chord of the blade is 30 inches wide with the outboard

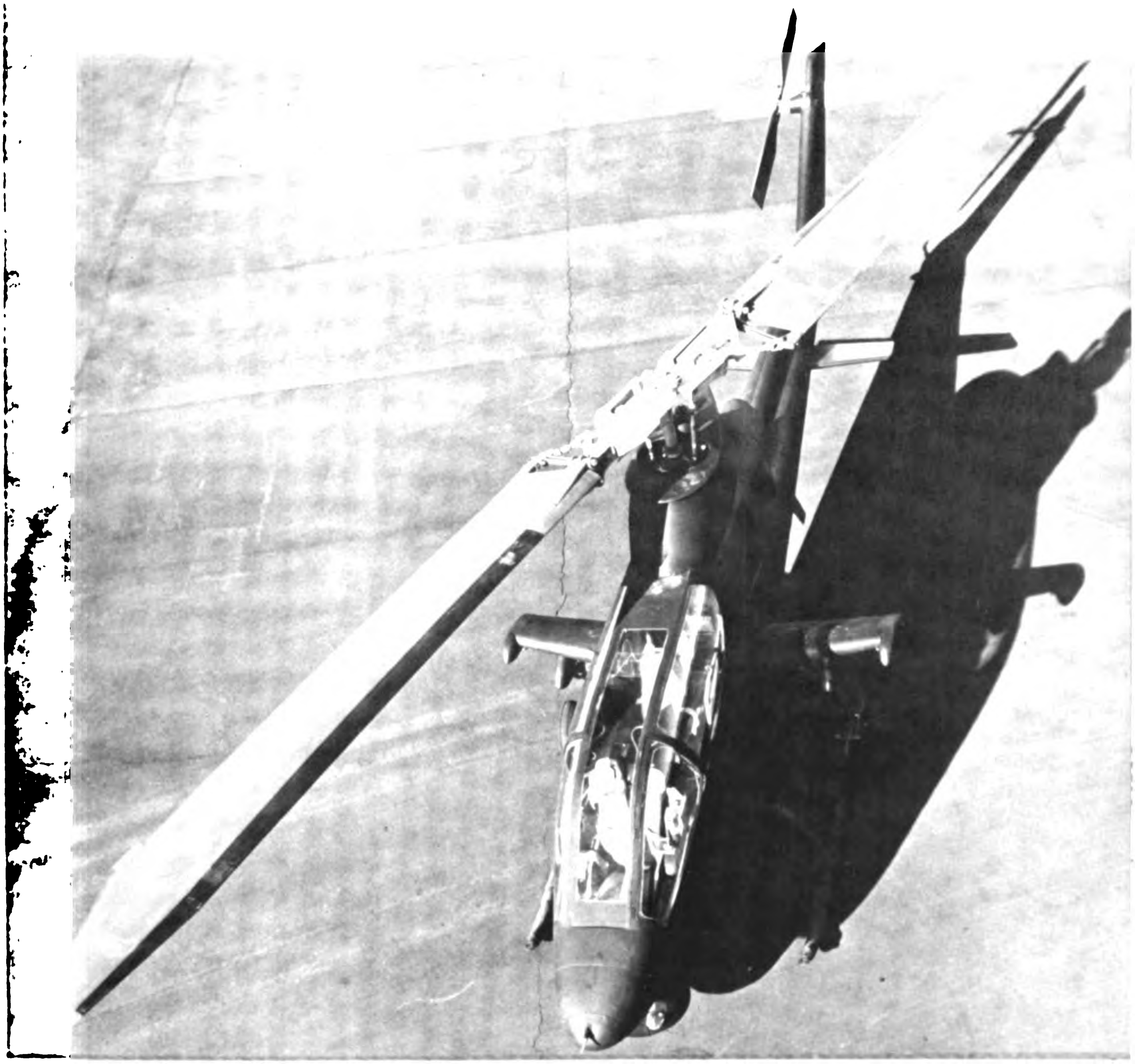
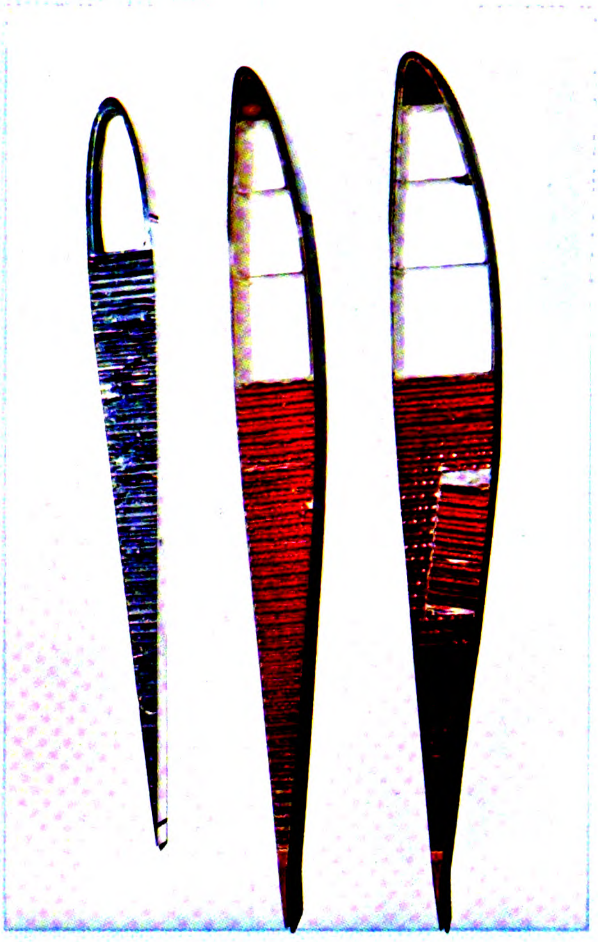


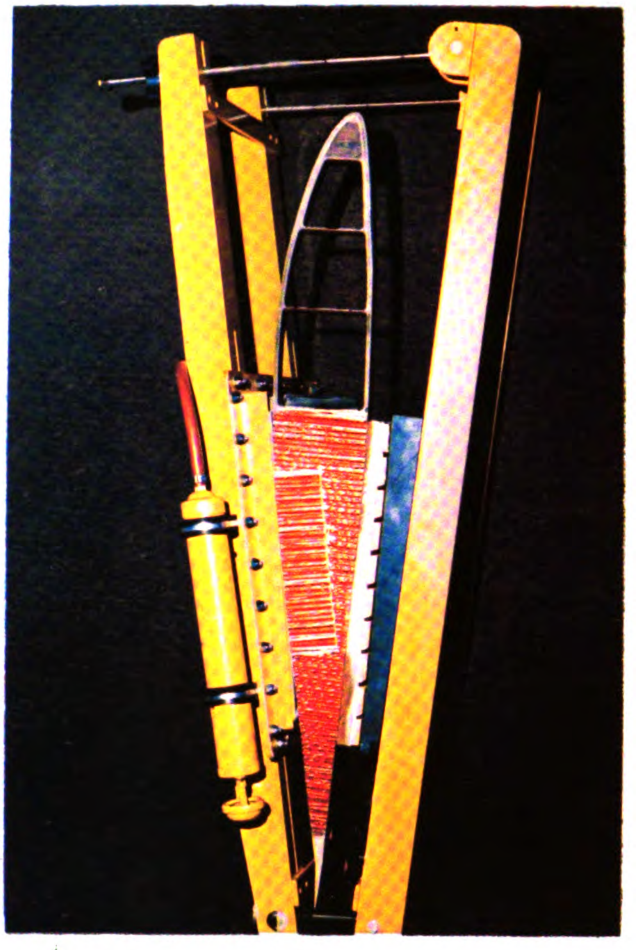
Figure 5 — improved main rotor blade installed on AH-1G Cobra helicopter

15 percent tapered in both chord and thickness.

Figure 6 shows the tapering effect of the new blade and compares it to the present metal blade. The new blade has been designed for almost total repairability of the skin and core aft structure by personnel in field units. This is accomplished with the aid of a heat-pressure pack tool, shown in figure 7, which can accomplish tbe repair of the blade without removing it from the aircraft. A survivability feature of the new blade will allow 30 minutes of flight after being hit with a single 23 mm high explosive, incendiary, tracer round and is invulnerable to a single hit 12.7 mm round. The "through damoge," which would result from this type of a ballistic hit involving both skins and the core, can be repaired by personnel in the field in less than three hours. The maximum allowable operating time for the new blade is 10,000 heurs which is on increase of 9,000 hours over the present metal blade.

CANOPY ESCAPE SYSTEM: A new crew compartment escape system provides a means of escape for the pilot ond copilot/gunner in emergency situations where normal egress is not possible. Operation is accomplished by a ballistic jettison system which explosively cuts the acrylic side windows from the canopy support structure while linear shaped charges and thrusters explosively





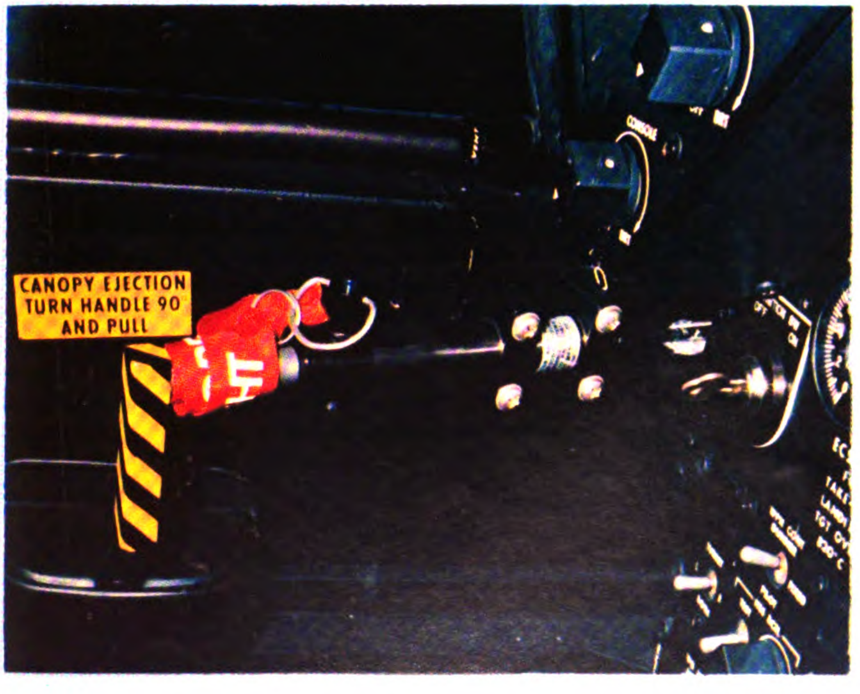


Figure 6 (Upper Left) — inboard and outboard cross sections of improved main rotor blade (top) and outboard cross section of standard metal blade

Figure 7 (Upper Right) — heat-pressure pack special tool installed on improved main rotor blade section incorporating repair

Figure 8 (Lower Left) — arming firing handle for pilots canopy removal egress system

separate the pilot and copilot/gunner entrance doors. It is totally independent of the aircraft electrical system or of any external energy source, and can be actuated only from inside the pilot or copilot/gunner station by either of two arming/firing handle mechanisms. Figure 8 shows the canopy removal system components for the pilot station.

Other significant improvements are shown in figure 9 and include:

Hydraulic Pump. An electrically driven pump which takes the place of the collective control accumulator which provides an unlimited number of collective strokes in the event of a main hydraulic system failure. It can be used for boresighting of the turret and TOW missile subsystems without the need of additional ground support equipment (Hydraulic Mule).

Rod End Bearing. An improvement to replace current rod end bearings of the hydraulic servo cylinder connecting tubes which will increase the fatigue life of the bearings to 3,300 hours.

Tungsten Carbide Bearing Sleeves. An improvement to replace main rotor teflon feathering bearing sleeves with a more durable materiel for increasing sleeve life.

Standard Lightweight Avionics Equipment (SLAE):

- ***ARC-114 Radio*** — An FM communication radio replacing the ARC-54/131. It is a smaller, lighter radio that is compatible with secure voice systems.
- ***ARC-164 Radio*** — A UHF-AM voice communication radio replacing ARC-51. It performs all ARC-51 functions but is smaller, lighter and compatible with secure voice systems. It provides 25 KHz spacing in the 224-400 MHz band.
- ***ARC-115 Radio*** — A VHF-AM voice communication radio replacing the ARC-134. It also is compatible with secure voice systems.

CONUS/NAV (ARN-123). Improves the AH-1S navigation capability by adding VOR and ILS receivers, glide slope, marker beacon and indicator lights.

Engine Deck Panels. A three piece engine deck designed to reduce bonding separations and provide for replacement of the forward and middle panels by field units. It also includes arms which support No. 1 hangar bearing.

Antitorque Controls. Provides push-pull tubes between tail rotor pedals and tail rotor pitch mechanism thus eliminating troublesome pulleys, sprockets, cables and chains. This improvement is included on the Mod "S" models.

Fire Detection. The system installed in the engine compartment includes a single loop sensing element connected to a control unit which activates fire warning indicators, located on the pilot's instrument panel.

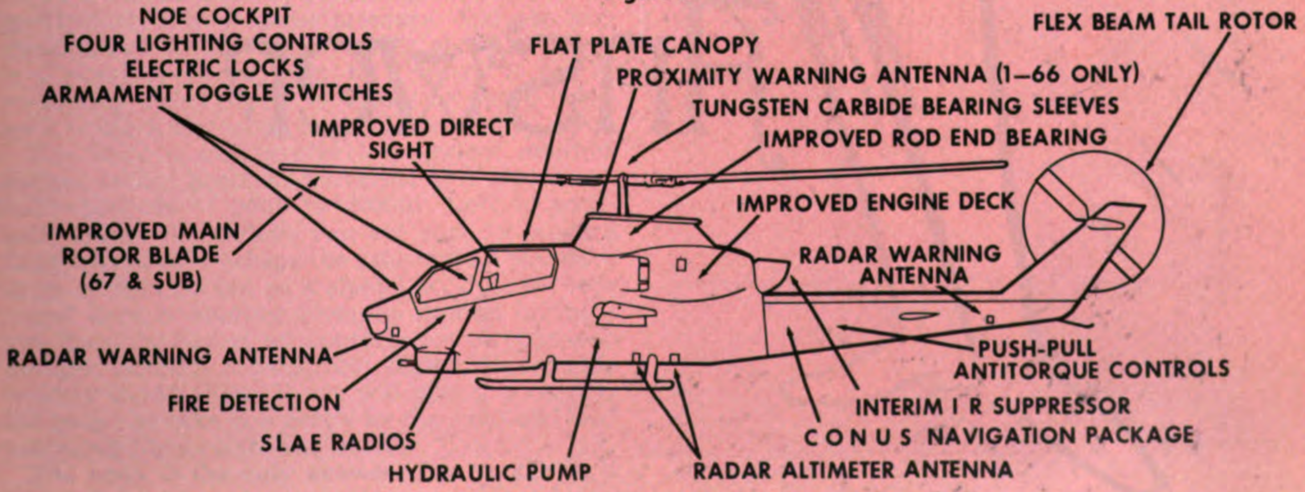
Flex Beam Tail Rotor. A simple uniball feathering bearing with a single piece hub which reduces maintenance and provides better antitorque controllability. This improvement is included on all AH-1 models.

The Cobra attack helicopter has proven itself to be a viable aircraft for today's antiarmor requirement. It also will complement the advanced attack helicopter in the high-low mix of attack helicopters in the U.S. Army fighting force of the future.

The next article on the modernization of the AH-1S will cover the new turret and weapons programs.

PRODUCTION AH-1S FEATURES

Figure 9



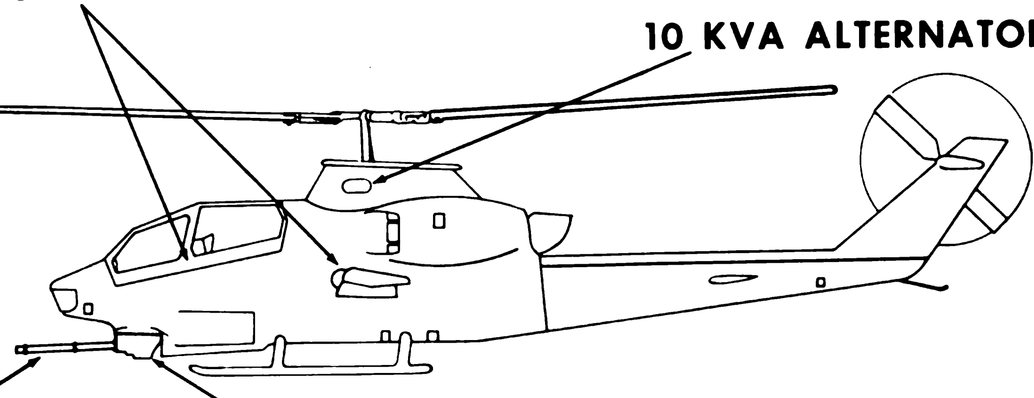


Figure 1—Production upgunned AH-1S features

MODERNIZED COBRA PART 2

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LAST MONTH part one of this article presented an overview of the AH-1 Modernization Program. It focused on the features of product improvements and how the resultant improvements will be incorporated into the Cobra TOW (tube-launched, optically-tracked, wire-guided missile) antiarmor attack helicopter fleet.

This article addresses, in part, the new weapon subsystems which will increase significantly the combat capability of Cobra TOW attack helicopters.

The requirement to modernize and "upgun" the Cobra was defined by a Special Study Group (SSG) during the Priority Aircraft Subsystem Review at Ft. Rucker, AL from November 1974 to December 1975. (See "Pass in Review," April 75 *DIGEST* and "The Upgun Dilemma," May 75 *DIGEST*.)

The SSG, under the direction of the commanders of the U. S. Army Armor and U. S. Army Aviation Centers, was comprised of representatives of TRADOC (Training and Doctrine Command), DACROM (Army Materiel Development and Readiness Command), subordinate commands, the Cobra Project Manager's Office and field commands. Following affordability analyses of the SSG recommendations by the Department of the Army staff, Required Operational Capability (ROC) documents were approved and used as the basis for structuring the current Cobra Modernization Program.

The first major effort to upgun the Cobra attack helicopter was included in the Enhanced Cobra Armament Program (ECAP). Bell Helicopter Textron (BHT) is the prime contractor and system integrator. The program is divided into two phases to best meet the funding and development time frames.

Phase I includes development and qualification of a universal turret to accommodate either the 20 mm or 30 mm weapon system and a Stores Management/Remote Set Fuzing Subsystem. It also will include aircraft interface aspects and the application of additional fiscal year (FY) 78 product improvement programs (PIPs).

Phase II includes the qualification of a new fire control subsystem, the incorporation of additional PIPs and improvements in aircraft survivability equipment. Phase II will be discussed next month in part 3 of this article. Figure 1 summarizes the basic features of the ECAP Phase I Program.

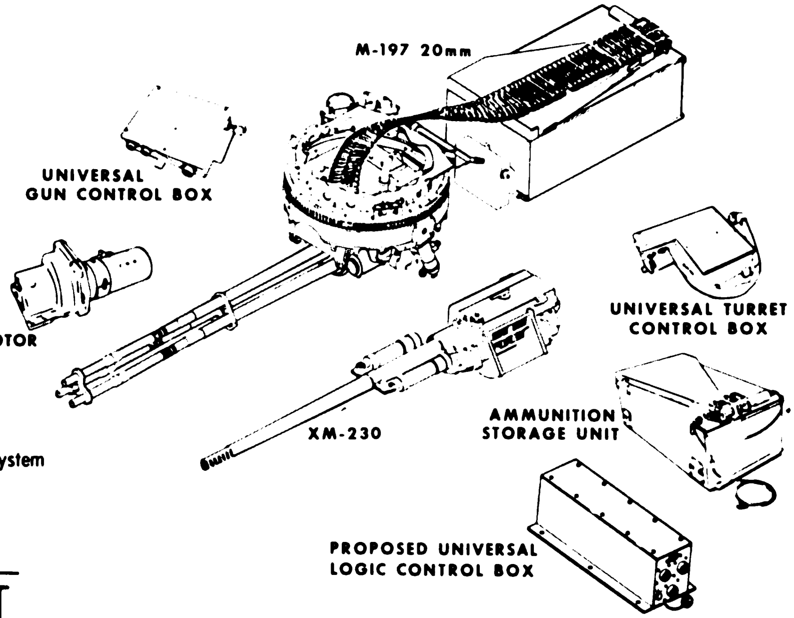

Figure 2— Universal turret system

UNIVERSAL TURRET

The universal turret will be developed and manufactured by General Electric, Armament Systems Department, Burlington, VT. The objectives of the Universal Turret Program are to provide an improved standoff capability, improve antipersonnel and antimateriel effectiveness and accommodate either a 20 mm or 30 mm weapon. This new turret eventually will replace the M28 (7.62 mm/40 mm) subsystem now installed in the Cobra.

The 101st new production AH-1S is scheduled for delivery this September. It will be equipped with the universal turret and the 20 mm, M197 gun. The 30 mm, XM230E1 gun is scheduled for installation on the AH-1S in May 1981. The Universal Turret is electrically powered and has a design weight limit of 175 pounds. The basic components of the system (figure 2) are the turret, linked feed system and three electronics boxes containing the turret, gun and logic controls.

In the AH-1S, the Universal Turret fires through ±110 degrees forward azimuth and has a variable elevation of 20.5 degrees maximum and a depression of 50 degrees maximum. Turret position is controlled by the pilot or copilot through helmet sights or by the copilot through use of the Telescopic Sight Unit (TSU) of the missile subsystem. The turret is electrically driven by two servo motors—one for azimuth and one for elevation. The motors receive position commands from either the TSU or helmet sights and feature quick response and safe, reliable operation.

As previously indicated, the universal turret will accommodate either the 20 mm M197 Vulcan or the XM230E1 Chain Gun. The saddle of the turret is designed to accommodate the slide mounts of the XM230E1 and the quick release pin mounting of the M197. The ammunition storage container is designed to hold either 20 mm or 30 mm ammunition. Partitions will be added to the container to accommodate the shorter 20 mm round. Ammunition chuting is easily exchanged by using quick release fasteners. The complete operation of interchanging gun, chuting and feed systems takes less than 30 minutes.

The M197 20 mm gun is shown in figure 3 mounted on the universal turret with its ammunition container. It fires standard M50 series 20 mm ammunition at a rate of 730 ±50 shots-per-minute with an effective range of 2,000 meters. For the AH-1S, the gun is held within the turret by a rear ball mount, a slider, and a low force recoil adapter. The low force recoil adapter reduces the recurring peak recoil load of the gun to about 1,150 pounds.

The XM230E1 30 mm Chain Gun is shown in figure 4 mounted on the Universal Turret with its ammunition containers. This weapon fires the XM-788789 (ADENDEFA) family of 30 mm ammunition (figures 5 and 6) at a rate of 730 #50 shots-per-minute and has an effective range of 3,000 meters. The recoil attenuating system, supplied as a part of the turret subsystem, will limit 30 mm gun recoil forces transmitted to the turret and provide compatibility with the TSU.

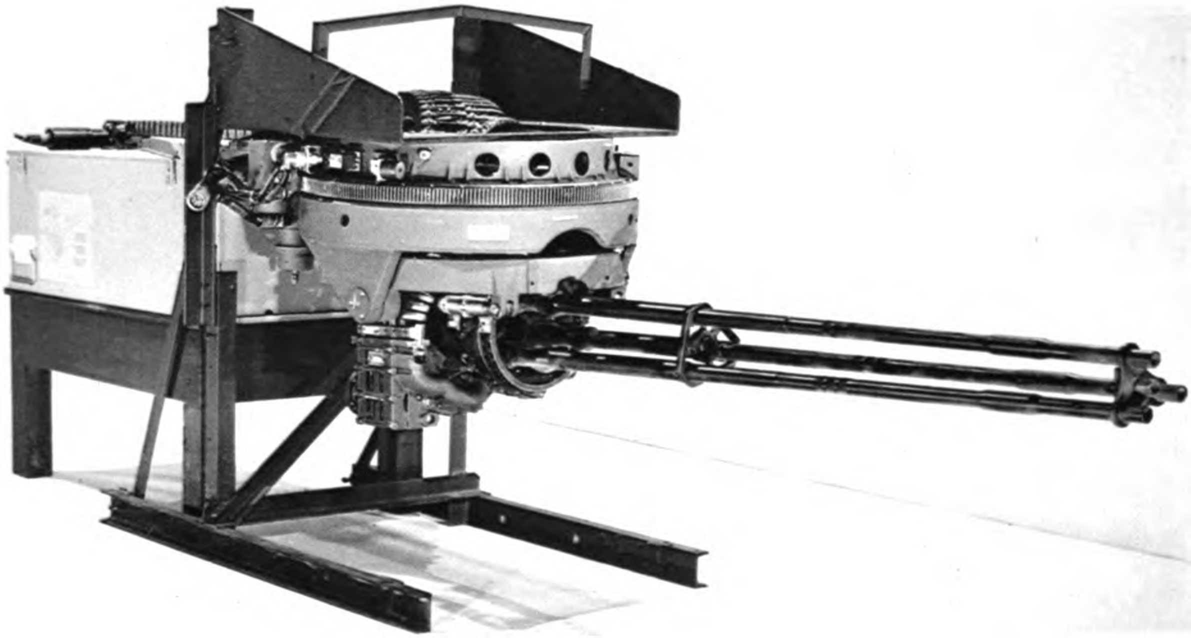

Figure 3—M197, 20 mm gun with ammunition container mounted in universal turret

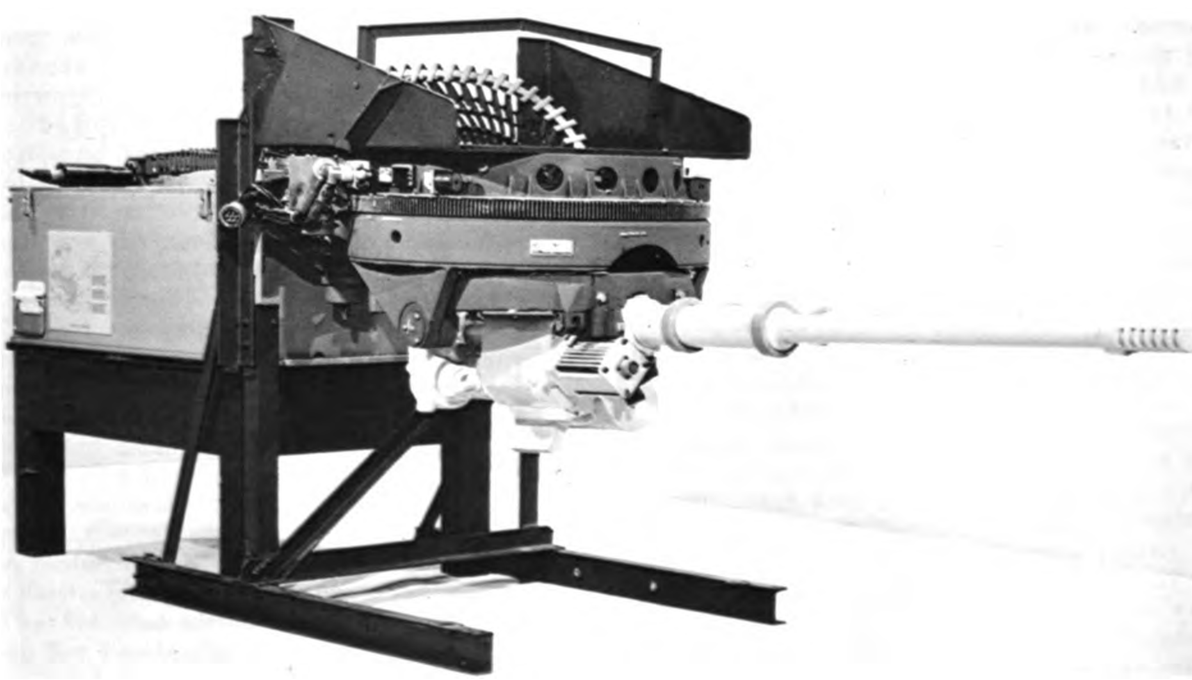

Figure 4—XM230E1, 30 mm chain gun with ammunition container mounted in universal turret

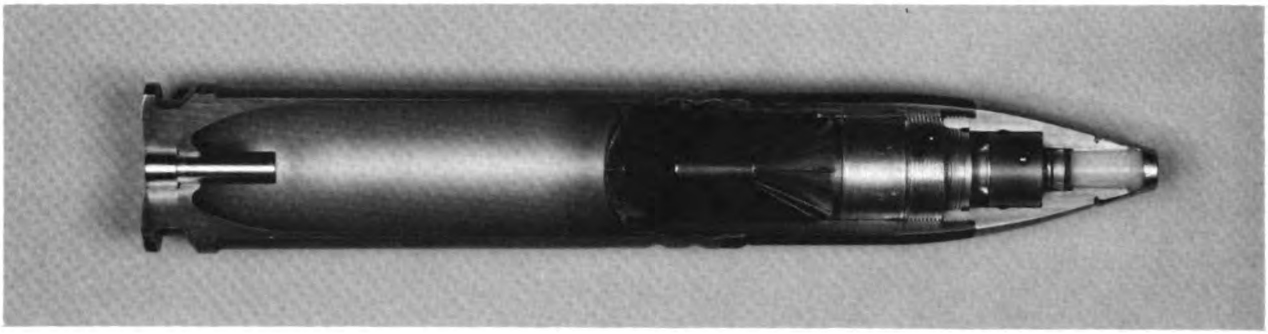

Figure 5—30 mm ADEN/DEFA type ammunition to be utilized in the XM230E1 chain gun (XM789)

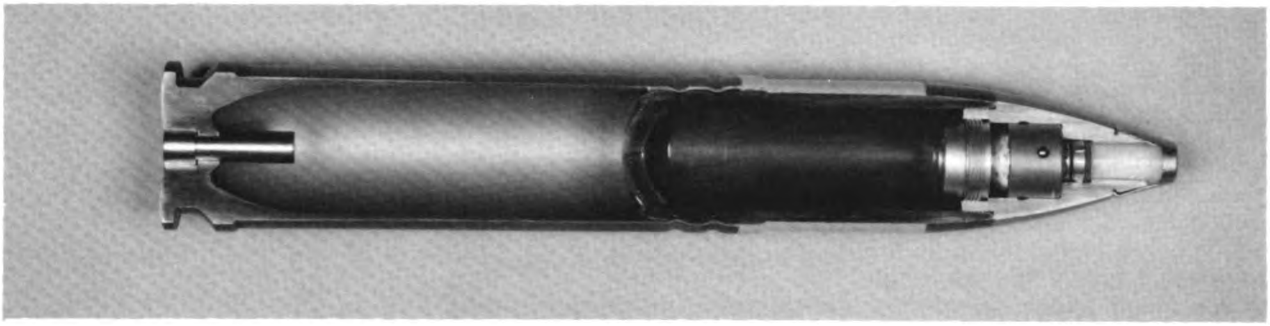

Figure 6—30 mm ADEN/DEFA type ammunition to be utilized in the XM230E1 chain gun (XM799)

TURRET AND CONTROLS

On the AH-1S, the turret is mounted under the nose of the helicopter, the same as the present M28 turret. The turret contains the components necessary for positioning and firing the gun as directed by the gunner from the sighting station. Positioning of the gun is performed by a gimbal and a saddle which moves the gun in azimuth and elevation respectively. The azimuth and elevation drives are powered by direct current motors through gear reductions. Electrical current for the motors is controlled from the servo amplifiers, located in the turret control box, which use the helicopter's 28 volt DC (direct current) power source.

The turret, gun and universal logic control boxes provide the electronics for all controls and switches in the system.

20 MM/30 MM LINKED STORAGE AND FEED SYSTEM

A complement of 750 20 mm or 500 30 mm rounds of linked ammunition is fed to the gun through flexible chuting from the ammunition box stored in the ammunition compartment of the helicopter. During firing, a small booster motor pulls linked ammunition from the box and pushes it into a section of flexible chuting which is connected to the gun's feeder. The booster eliminates excessive belt pull loads, which occur when the belt is pulled on by the delinking feeder, and eliminates the requirement to manually fill the chute during loading.

2.75 INCH ROCKETS

The 2.75 inch rocket subsystem has been one of the primary aerial weapon systems used on the Cobra. It provided valuable support to ground units during the Vietnam conflict.

There are several development programs that have been initiated by the 2.75 Inch Rocket Project Manager to improve the warheads and launchers to be used on the modernized Cobra. The basic 2.75 inch rocket motor and the available warheads are shown in figure 7. The submunitions and chaff warheads are the newest developments in the warhead program.

During the SSG review in 1974-5, the weight of any prospective improvement was a key consideration in structuring the modernized Cobra program. As a result of the weight factor, a requirement for lightweight 7 and 19 round launcher development was established. The design features of these launchers are illustrated in figures 8 and 9.

The Stores Management/Remote Set Fuzing Subsystem developed and manufactured by Baldwin Electronics Incorporated, Little Rock, AR, will use the 2.75 inch warhead and launcher improvements to enable more effective mission accomplishment by Cobra crews. This subsystem is scheduled to be installed on the 101st new production AH-1S in September.

The control panel for the stores management/remote set fuzing subsystem is shown in figure 10. The panel will provide the means to select and fire, while in flight, any one of five types of external rocket stores. It will allow the pilot to set range and select the fuze setting best suited to the type target being engaged to include settings which will permit penetration of tree canopies or fortifications protecting selected targets.

Although electrical power requirements for the AH-1S continue to increase, adequate power will be available to operate subsystem changes described in this article, plus several high electric power demand devices forthcoming.

Beginning in September 1978, modifications will include the installation of alternating current alternators on the transmissions of all Cobra S models produced.

The weapon subsystems discussed above, coupled with the TOW missile, and the versatility of available ordnance will provide Cobra crews with the required firepower to accomplish missions of antiarmor, direct aerial fire support and armed escort/reconnaissance. The commonality of guns, rockets and missiles will enhance the effectiveness of rearming at forward area rearm and refuel points (FARRPs). The survivability of the crews will be improved greatly with the added standoff capability; the accuracy and effectiveness of the new weapons and ammunition; plus the capability to remotely select the correct fuze setting for the type target being engaged. The enhanced armament subsystems on the modernized AH-1S will keep the attack helicopter a viable member of the Army's combined arms team for many years.

Next month part 3 of the "Modernized Cobra" will cover the fire control, aircraft survivability equipment, laser rangefinder, and the laser tracker programs.

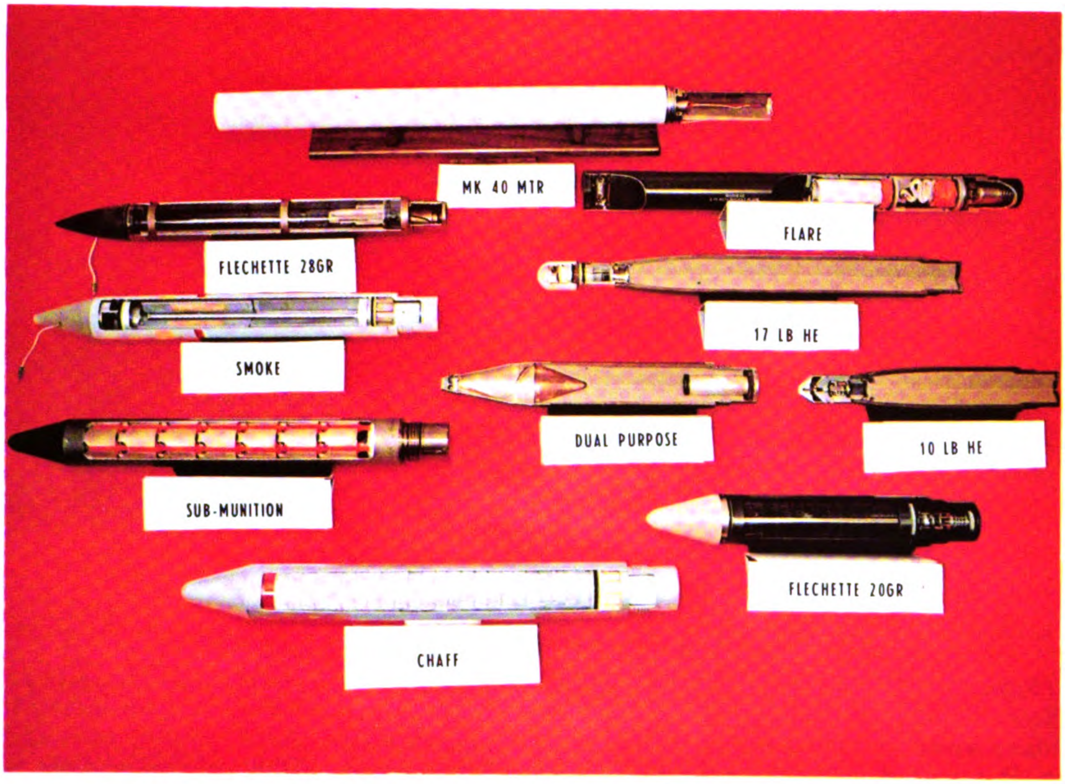

Figure 7—2.75 inch rocket motor and warheads

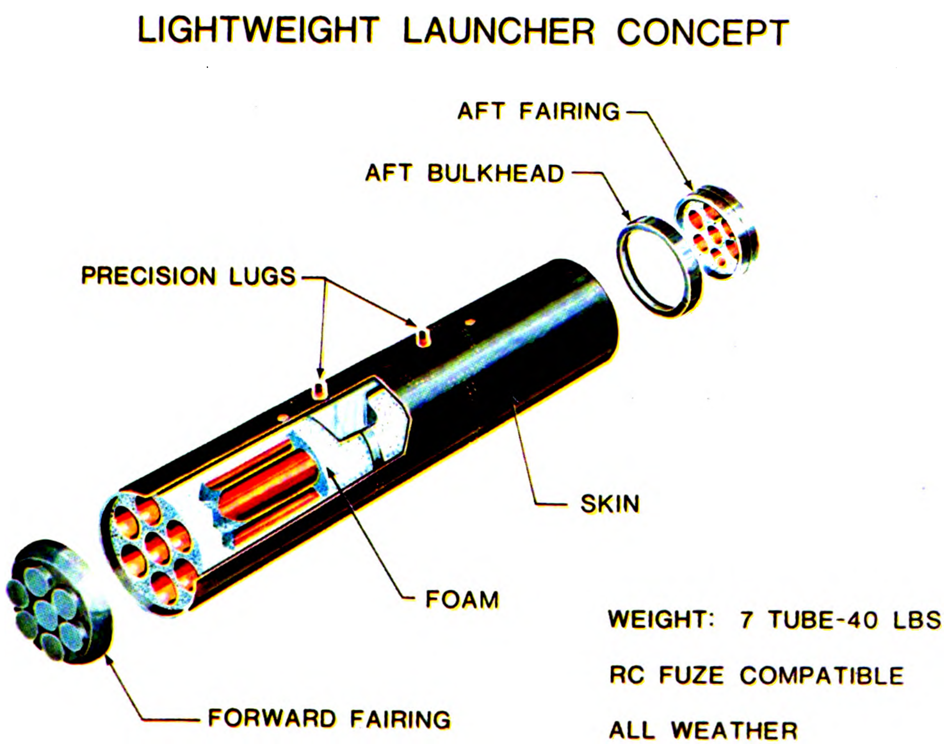

Figure 8—7 round 2.75 inch rocket lightweight launcher

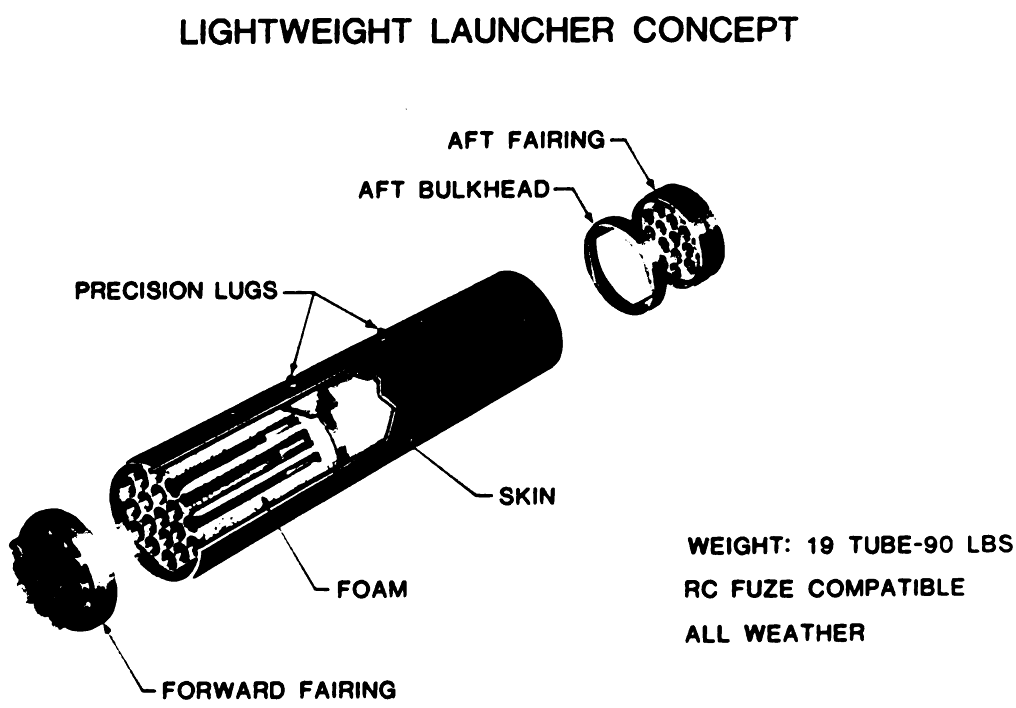

Figure 9—19 round 2.75 inch rocket lightweight launcher

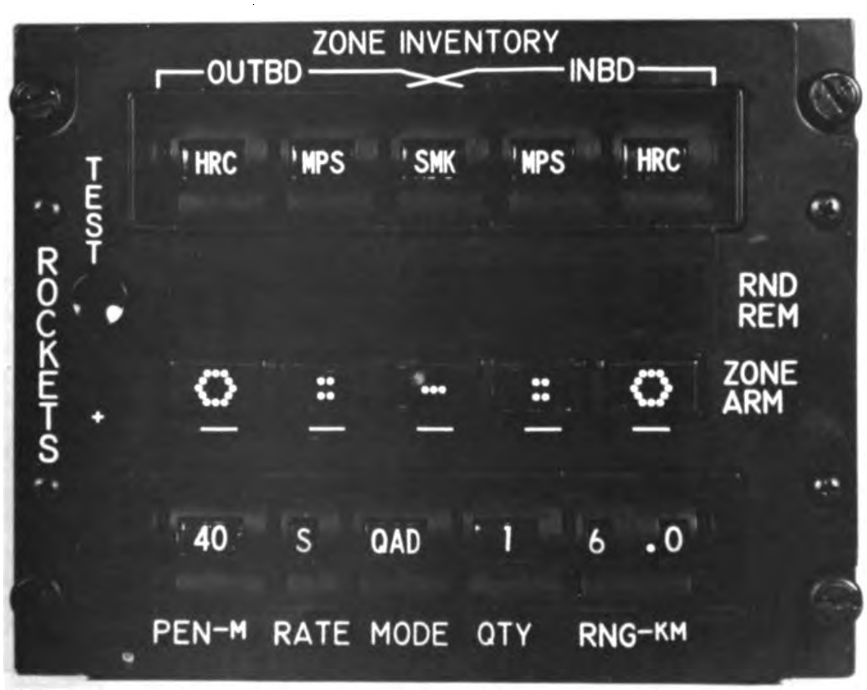

Figure 10—Control panel for stores management and remote set fuzing subsystem

2.75 Update
Whatever Happened To "The Egg On The Wall"?

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Project Manager
2.75 Inch Rocket System
Redstone Arsenal, AL

A FEW years ago my predecessor, Brigadier General Frank (Rags) Ragano, described in this magazine a new lethal warhead, the Multipurpose Submunition (MPSM) Warhead. Its functioning characteristic was likened to that of a raw egg thrown against a wall. (See "Zee Egg Versus Zee Tank," May 1975 *Digest*).

By means of these written words I am pleased to present to you an update on this and other 2.75 inch rocket system improvements.

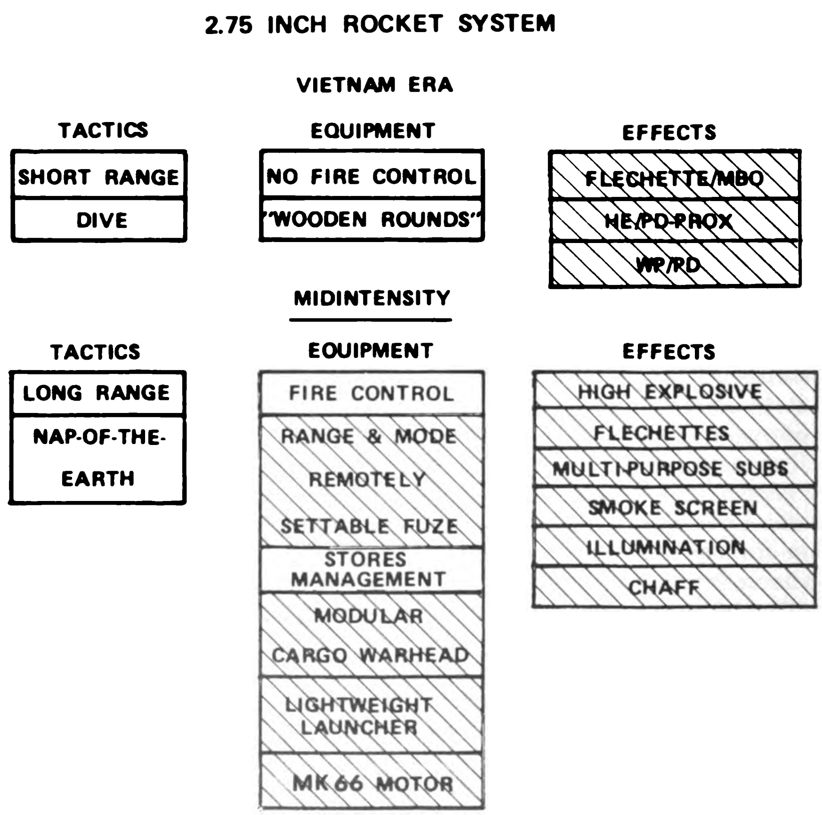
My subject separates nicely into several general categories: those improvements on the aircraft that are going to contribute to better rocketry; improvements in system lethality; progress with our nonlethal or supporting warheads; improvements which increase system range and reduce its weight; and finally, some "off-the-wall" warhead concepts for your consideration.

Improvements To Better Rocketry. First then, a look at the aircraft system improvements to rockets. Very briefly and perhaps in review, the rocket related tactics, equipment and effects we had in Vietnam are known to most of you. As we looked to mid-intensity, the Army rapidly identified and developed new tactics and doctrine. The complementing new equipment takes a little longer; nonetheless, much work is being done in this regard and that's what this article is all about. The effects that come from this equipment, of course, are the type that have been identified as being necessary to fight and win in that mid-intensity environment. They were supported by Training and Doctrine Command's Pass In Review Study (see "Pass In Review," April 1975 *Digest*, and "The Up-Gun Dilemma," May 1975 *Digest*) and by the Selected Effects Armament System (SEAS) Cost and Operational Effectiveness Analysis (see "SEAS COEA," April 1975 *Digest*).

Shown in shaded boxes of figure 1 are those areas for which the 2.75 inch rocket system project office has responsibility, and under the equipment category that means the fuze, the warhead, the motor and the launcher. The fire control and stores management are responsibilities that fall under the purview of the aircraft project manager; but let me touch on them briefly as to what they mean to the rocket system.

First, the *fire control*. The critical part of fire control is the laser rangefinder which will correct the massive problem related to a 25 percent range estimation error which is experienced

1. Comparative Use Of 2.75 Rocket System

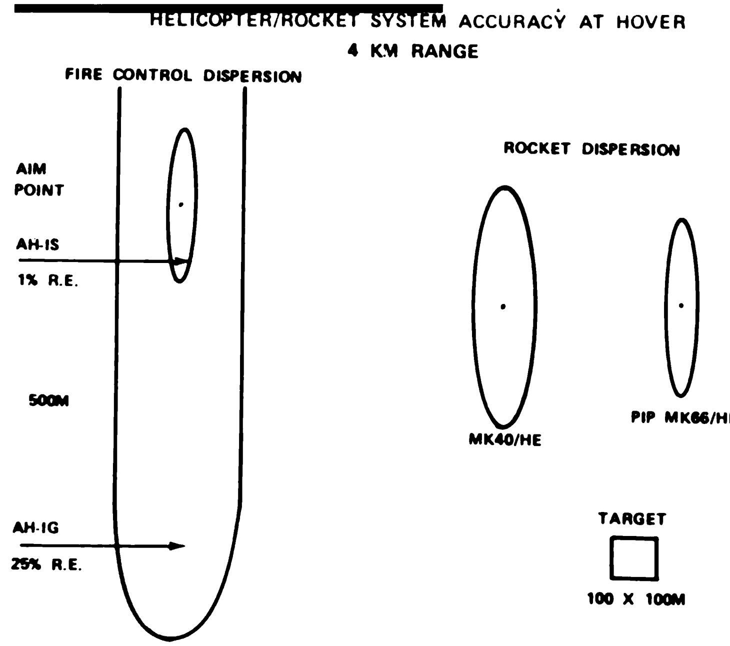


with our human system and bring it down to 1 percent (figure 2). This means that the aim point variation due to this range error will be drastically reduced in size. In terms of the traditional ellipse pattern we will see an 80 percent reduction in the aim point variation. The current Mark 40 Motor has a ripple ballistic pattern of some 19 mils. With the existing range error combined with the rocket ballistic characteristics, it's not surprising that one gets the large inaccuracies that many know so well. Unfortunately, and all too often, the wide spread knowledge of these inaccuracies provides the basis by which many improperly judge the worth of ongoing system improvements. It is readily seen that a significant improvement will result just by eliminating the current range estimation error, and this the fire control will do. You will start to see fire control in AH-1 Cobras in the latter part of 1979.

The second area I would like to mention relates to *stores management and fuze setting*. On a cockpit panel similar to the one of figure 3, pilots will be able to choose the type of warhead they want to fire by selecting the zone within the launchers from which it is to come. They will apply the fuze setting that they want for the rocket depending upon its purpose and they will select the quantity to be fired. Pilots also will be able to set the rate of firing and, as you can see from the panel, much other information will be available to them, all key benefits.

One point further about stores management and the zone from which a rocket will come: in our current launchers, we don't have such a capability, but in the future, the Lightweight 7-Tube Launcher will have two zones, one consisting of three tubes and the other of four.

Moving to the 19-Tube Launcher, these same zones are retained within the center seven tubes, but, a third zone of 12 rockets is added with the outer ring. Fuze setters and stores management will begin appearing on our AH-1 Cobras around the end of this year.



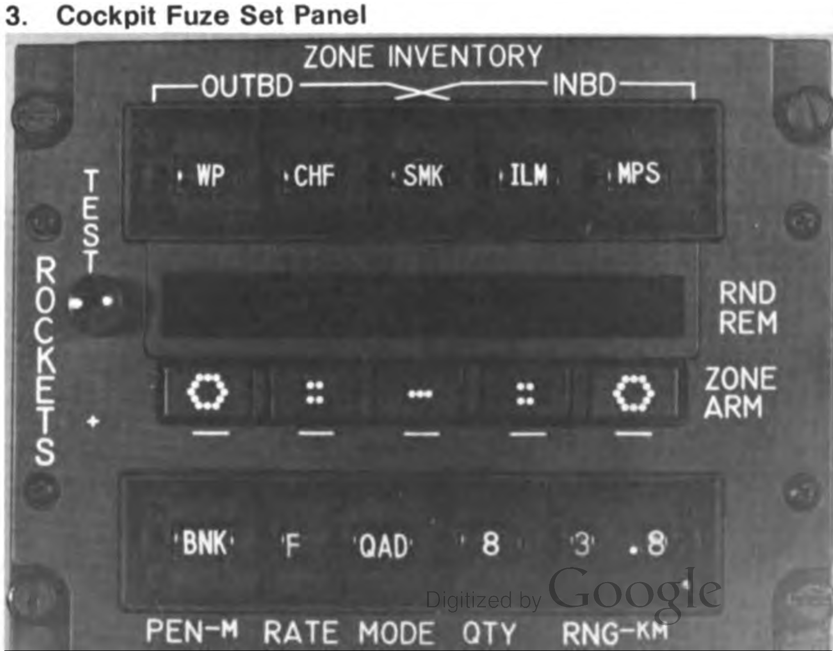
2. Fire Control System Accuracy At Hover—4KM Range

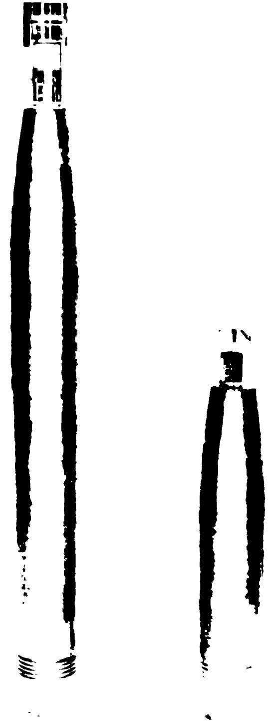
Lethal Warhead Improvements. I would like now to move into the specific improvements for which I am responsible, dealing first with those related to improvements to our lethal warheads.

Two old friends are still in our inventory, the M229 17-pound Warhead and the M151 10-pound high explosive (HE) Warhead (figure 4). Fuzes available are proximity and point detonating. Well, what are we doing to these old friends? We are adding the new remotely set M433 multioption fuze (figure 5). With it, inflight and from the cockpit, the pilot then can select a super quick mode or two variations in delay; one is related to tree height for a forested target area and the other is the delay necessary to achieve a penetration through a bunker or building. The M433 fuze should very much enhance the utility of the HE Warhead. With availability dependent upon the allocation of procurement funds, this new warhead is scheduled to become available during 1980.

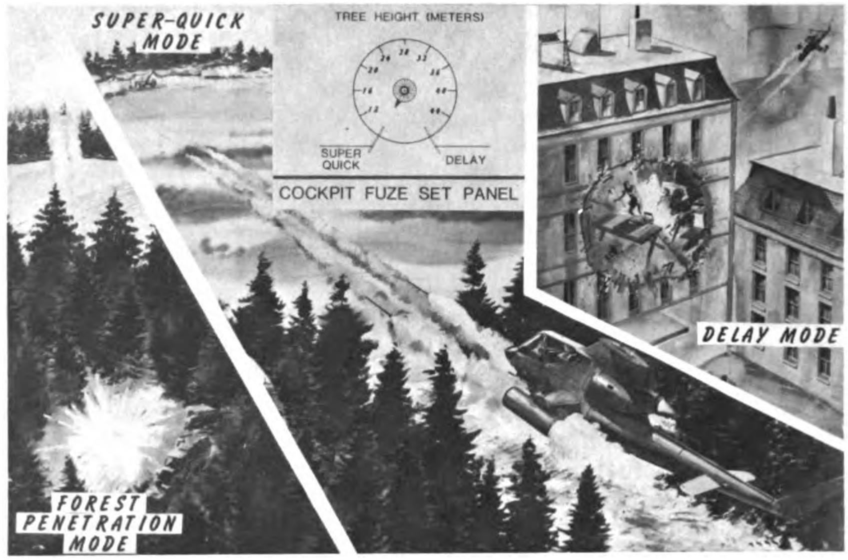
The other fuze of the remotely set family is the M439 fuze (figure 6). It is settable in terms of range, either manually dialed from the cockpit in 100-meter increments, or automatically set from the rangefinder input to the fire control com-

3. Cockpit Fuze Set Panel





4. **M-229 Warhead (L) And M-151 (R)**



5. **M-433 Remote Set Multioption Fuze/2.75 HE Warhead**

puter and then through the fuze setter electrically to the rocket warhead. This means that the aircraft from a given firing position will be capable of engaging several different targets at differing ranges with different warheads, all without moving the aircraft.

With the performance of this fuze kept in mind, I would next like to describe the most impressive of the new developments, the MPSM Warhead. It is the warhead to which the "egg on the wall" concept applies. The concept is alive and technically very well. Shown in figure 7 in cutaway, this warhead will have 9 submunitions stacked as shown. Using variable range feature of the M439 fuze they will be expelled at a selected point along the trajectory. Each submunition is multipurpose in that it is effective against personnel, materiel and armor. The submunition has a high drag device such that when each is expelled from the warhead it is, in short order, reduced in velocity and separated from others, achieving a vertical orientation as it falls to the ground.

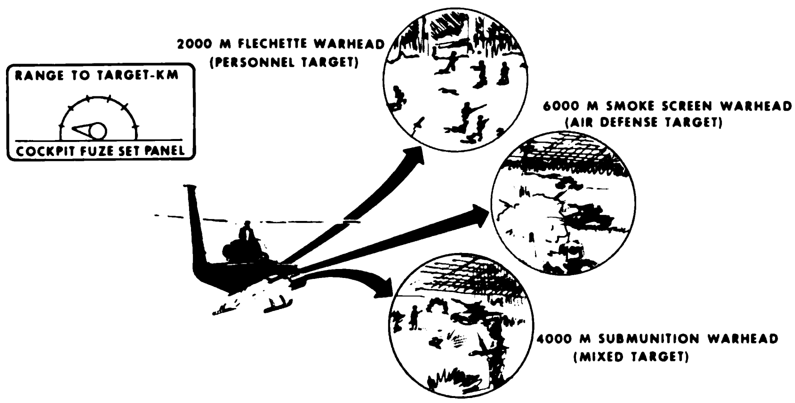
As determined by the Army Materiel System Analysis Agency, (AMSAA) effectiveness against prone personnel is particularly impressive. Each warhead has five times more lethal area than the standard 10-pound warhead. Significant results also are obtained against materiel and penetration of armor is achieved from the shaped charge that is within each submunition. Given hits, very significant probabilities of kill are obtained against point targets of armor. Consequently, while the MPSM Warhead is not designed to be an antiarmor type weapon, it nonetheless carries with it a lethality that could not comfortably be ignored by an enemy.

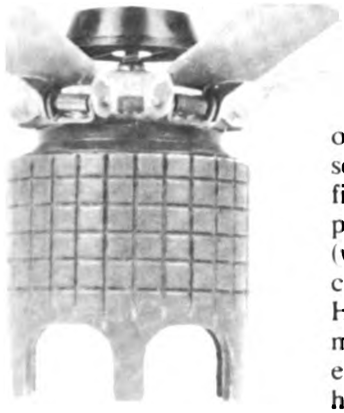
How have we done in tests to date? During the spring of last year at Yuma Proving Ground, AZ the air launched phase of DT I Tests was conducted. Most of the impact data are described by figure 8. Notice the 250 meters by 350 meters pattern, the direction of fire, and the fact that AH-1G was standing off 2,500 meters.

For reasons of economy during the advanced development phase, only seven submunitions were contained in each warhead. Shown are the results of 32 warheads, fired from a hover or 20 knots (kts) single or in pairs. A new sight alignment was assumed prior to each single or pair firing. Firing from a hover was performed intentionally with sight settings of both 39 and 129 mils. We wanted to confirm that variations of pitch attitude normally unintentional, did not significantly affect the pattern's location; and indeed we found that to be consistently true.

The final firing of eight warheads was with 20 kts forward flight, firing singles. This was done by eight consecutive passes over the firing point at that same speed and while the

6. **M-439 Range Remote Set Fuze/2.75 Cannister Warhead**





7. XM-261 MPSM Warhead

sight setting was 83 mils. We did have unintentional variations in pitch attitude; nonetheless, the impact area and pattern remained essentially unchanged from that of warheads fired from the hover. The findings are more significant and clearly show a vast improvement in tightening up of the impact pattern over that which we expect today with the standard 10-pound HE Warheads.

Now what does this mean in terms of effectiveness? Available analyses tell us that today with 38 rockets fired on 100-square meter prone personnel target at 4,000 meters (with our current AH-1G, 25 percent range error, and Standard HE Warhead), we could do little more than frighten the enemy. However, with the Submunition Warhead combined with the fire control now being developed for the Cobra, the casualties would exceed any and all expectations.

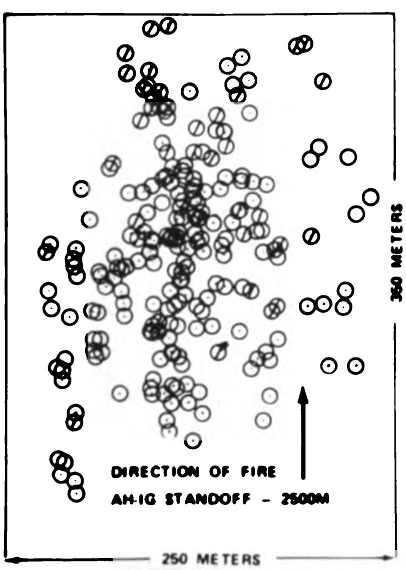
There is every reason to be optimistic about what to expect from this high payoff warhead. Tests show that we have an acceptable item already from the standpoint of lethal area and armor penetration. Pitch variation sensitivity virtually has been eliminated because of the excellent performance of the high-drag device of the submunition. We officially completed advanced development in October of 1977 and progress in fiscal year (FY) 78 is dependent upon the extent to which funding can be identified.

Supporting Warheads. Turning now to the supporting type warheads, the first one that I would mention is the Screening Smoke "Wick" Warhead. Shown in figure 9 in cut-away is the new warhead. It has 10 perforated metallic "wicks" filled with fiberglass which are contained in a canister filled with white phosphorus. When the warhead functions the canister bursts, creating a cloud of white phosphorus in the air, with the 10 wicks streaming individually to the ground. One would see the trail they cause for about 5 minutes. These wicks provide a continuing source of smoke, thereby creating a very effective smoke screen.

Two different configurations will provide for both fixed and variable range fuzing. The fixed distance smoke as demonstrated during DT/OT 1 could be available in 14 months. This period reflects the time needed to obtain the money, administer a contract, and then produce the warhead. A special in-process review (IPR) was held in September which recommended that the warhead be type classified; thus, it will be cleared soon for an urgent procurement to meet contingency and training needs. Procurement is planned for FY 79.

With respect to the preferred Smoke Warhead, the remotely set fuzed variable range version, we have just completed a year of inactivity due to a lack of dollars, but engineering development will now start in earnest in FY 78 with fielding planned soon thereafter.

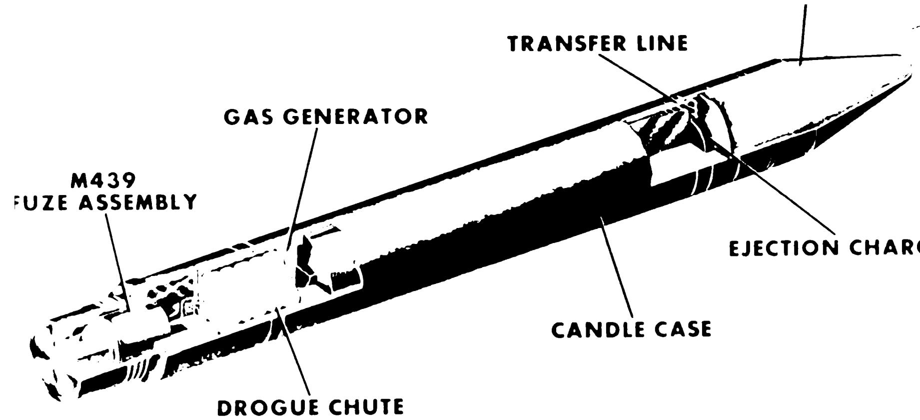
Many valuable lessons should follow the fielding of a Smoke Screening Warhead. There are differing opinions as to the use of Smoke Warheads from attack helicopters capable of carrying antitank missiles. Some believe that missiles must make up the total wing store load, but I strongly believe that if it has not already arrived, the day will come soon when the firing of smoke in support of tank killing missions is as much a part, one with the other, as fires are to maneuver and that



#WHDS	AIR SPEED	TYPE FIRE	SITE SETTING
8	HOVER	SINGLES	39 MILS
8	HOVER	PAIRS	39 MILS
8	HOVER	SINGLES	128 MILS
8	20 KTS	SINGLES	83 MILS

8. DT-1 Results (Air Launched)

9. Smoke Warhead XM-259



10. Illumination Warhead XM-262/263

habitually, some of the attack helicopters assets will always fire smoke and other supportive suppressive fires while the balance of the force engages tanks with its missiles. This view is not widely held.

It might be useful to ponder some key questions with regard to smoke for aviation; for instance, who delivers it? When and how is it employed? If the answers to these questions require rocket delivery of smoke, we will need to train for this role. Hopefully, the imminent type classification action will clear the way for a procurement so attack helicopter units can get on with this important training task.

The Illumination Warhead is another one that we are working on. Shown in figure 10 as a cut-away, it will ultimately use the same variable range fuze that I have already described. In concept, the expected use of the Illumination Warhead is shown in figure 11. First, we see an aircraft firing illumination into the darkness, toward a suspected target area. By the illumination provided, targets are illuminated and then subsequently engaged by either ground antitank weapons or from the aircraft firing tube-launched, optically-tracked, wire-guided (TOW) or Helicopter Launched Fire and Forget (HELLFIRE).

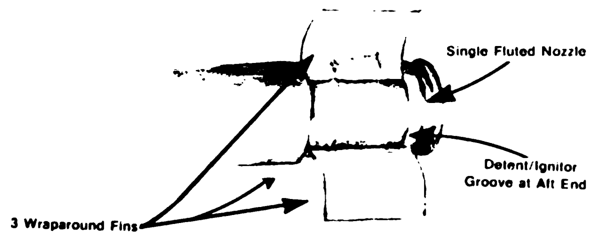
What's the status today? As you are probably aware, there is a current Standard M257 Illumination Warhead which we are now procuring for the first time. In fact, a recently signed contract with Thiocol will provide for 50,000 illumination rockets. The first of this quantity should reach the field around the end of 1978. The M257 will provide more than a million candle power for 2 minutes but there is one drawback. It functions at the single range of 3,000 meters. This means that the parachute flare was designed for low ejection velocity. The need for variable ranges requires a new design development, hence the follow-on illumination warhead is essential. With regard to the new development item, progress was begun in FY 76, then stopped when dollars ran out. No further progress has been made or will be made pending the availability of dollars. They are not now programed until the FY 80 budget because of the low priority of the effort.

The Variable Range Illumination Warhead will have the same performance as the M257 in terms of illumination and duration but it will incorporate the fuze which can be manually or automatically set from the cockpit for the desired range. It will be designed for the variable

11. Illumination Warhead Firing

Enemy Returns Fire. Attack Helicopter Repositions Self

Helicopter Attacks Illuminated Targets With TOW Or HELLFIRE



MK66 MOD O Motor

MK66 MOD 1 Development Goals:
- **Retain MK66 MOD O Performance**
- **Redesign Fin And Nozzle**
- **Increase Spin To Achieve 7-9 Mil Accuracy At Hover**
- **Relocate Detent/Ignitor Contact For Launcher Compatibility**

12. Mark 66 MOD 1 Tri-service Motor

velocities that the parachute would experience at the near and far ranges. Because of our delay in getting started it may not be available for some 5 to 6 years.

Less Weight And Greater Range. Next, I would like to address the system improvements which brighten the picture regarding system range and weight; first the range improvement. In FY 78 we have begun the development work necessary to introduce the Navy-developed Mark 66 higher velocity rocket motor into the Army and eventually Tri-Service inventory. In view of the goal to maintain interoperability with North Atlantic Treaty Organization (NATO) launchers, I am confident we will see it there too (see figure 12).

The Army has decided that it wants the Mark 66 because of its higher velocity, which in turn gives us a direct fire range capability to 6,000 meters; this is about a 2,000-meter improvement over that of the Mark 40. While we want to retain the velocity characteristics of the Mark 66, its current design in the fin and nozzle area and of the electrical contact are incompatible with current Tri-Service launchers.

Our program will address the compatibility problem and, at the same time, incorporate into the fin and nozzle area the best known design concepts for achieving an improved ballistic accuracy when rockets are fired from a hovering helicopter. By focusing on fin and nozzle redesign, we can expect a motor which is less sensitive to the very difficult downwash environment. From this program should come tighter patterns, greater range and higher velocity.

The Lightweight Launcher (LWL) is under development by Hughes Aircraft Company. One of the latest prototypes is shown in figure 13. This launcher is quite different from what we have today. The 19-tube launcher is expected to weigh 80 pounds; that is nearly 65 pounds lighter than one of our current launchers when modified for remote fuze setting. The 7-tube launcher will weigh under 40 pounds. The launchers will be capable of eight or more firings per tube. Today's M200 Launcher is reusable, many more than eight times, and is repairable. The LWL will incorporate the wiring for the remote fuze setting and also will have the provisions for environmental protection of the rockets so that they can be fired under flight conditions of moderate icing. There are a number of improvements to be found in the new "Lightweight Launcher." Deliveries are expected during the last half of 1979.

In this article, I have tried to present the latest status of our funded rocket system improvements. Recognizing that some of what I have written may spark a response, this author invites the comments and/or inquiries from your readers. I appreciate fully that ideas of value can come from anyone within our broad base of rocket users and supporters.

Whether or not you have comments or ideas regarding the 2.75 inch rocket system, you can be certain of one thing—it is a totally new system which is coming with capabilities so vastly improved over what we now have—you may have to see it to believe it. And see it you will!

13. New, 19-Tube Lightweight Launcher

MODERNIZED COBRA

Cobra Program Position Report

Colonel Jay W. Pershing
Project Manager, Cobra, TSARCOM
St. Louis, MO

THE AH-1S modernization program has continued to progress since it began in 1975. Today we are about halfway through the modernization effort and are fielding the new production Enhanced Cobra Armament System (ECAS) Cobra with the 20 mm cannon and universal turret.

The chart on page 4 provides an overview of the total modernization effort. The delivery schedules for the different AH-1S models are shown in each block. New production deliveries are shown in step 1 (production S), step 2 (up-gun S) and step 3 (fully modernized S). Modification of the existing AH-1G fleet is shown in the top block (mod S) and step 3 (AH-1G to fully modernized S).

Major modifications being added to the AH-1S in the separate steps include the tube-launched, optically-tracked, wire-guided (TOW) missile system, helmet sight subsystem, up-rated engine and powertrain, improved avionics and aircraft survivability equipment, universal turret with a 20 mm cannon, rocket management subsystem and fire control system. Details of these improvements are discussed in the three modernized Cobra articles at the center of this issue.

Completion of the three steps of the recycle program shown at the lower right of the chart will provide the Army with a standardized Cobra fleet with increased firepower and performance. Fielding of the 98 aircraft shown in step 2 of the chart has been accomplished at Ft. Hood, TX; Ft. Campbell, KY; Ft. Bliss, TX; and Ft. Bragg, NC.

Fielding of the remaining aircraft in step 2 began at Ft. Carson, CO last month. As a matter of interest, the aircraft assigned to Ft. Bliss were the first to be equipped with the new improved main rotor blade. It is planned that all future new production aircraft will have the new blades installed.

As the new production AH-1S Cobras are fielded, the remaining AH-1G fleet is being phased into the Bell Helicopter Amarillo, TX facility for modification to the fully modernized AH-1S aircraft. After next month all aircraft delivered from the new production line in Ft. Worth, TX and the modification line in Amarillo will be in the fully modernized configuration.

Operational readiness rates for the Cobra/TOW aircraft have met or exceeded the Department of the Army standard of 70 percent since its initial fielding in 1975. The overall Cobra fleet (AH-1G and AH-1S) operational readiness (OR) rate was 78 percent in February 1979. This was the highest OR rate ever achieved by the AH-1 fleet.

The contractor's testing of the fully modernized AH-1S with the new fire control subsystem was completed last June. Test results to date on the fully modernized

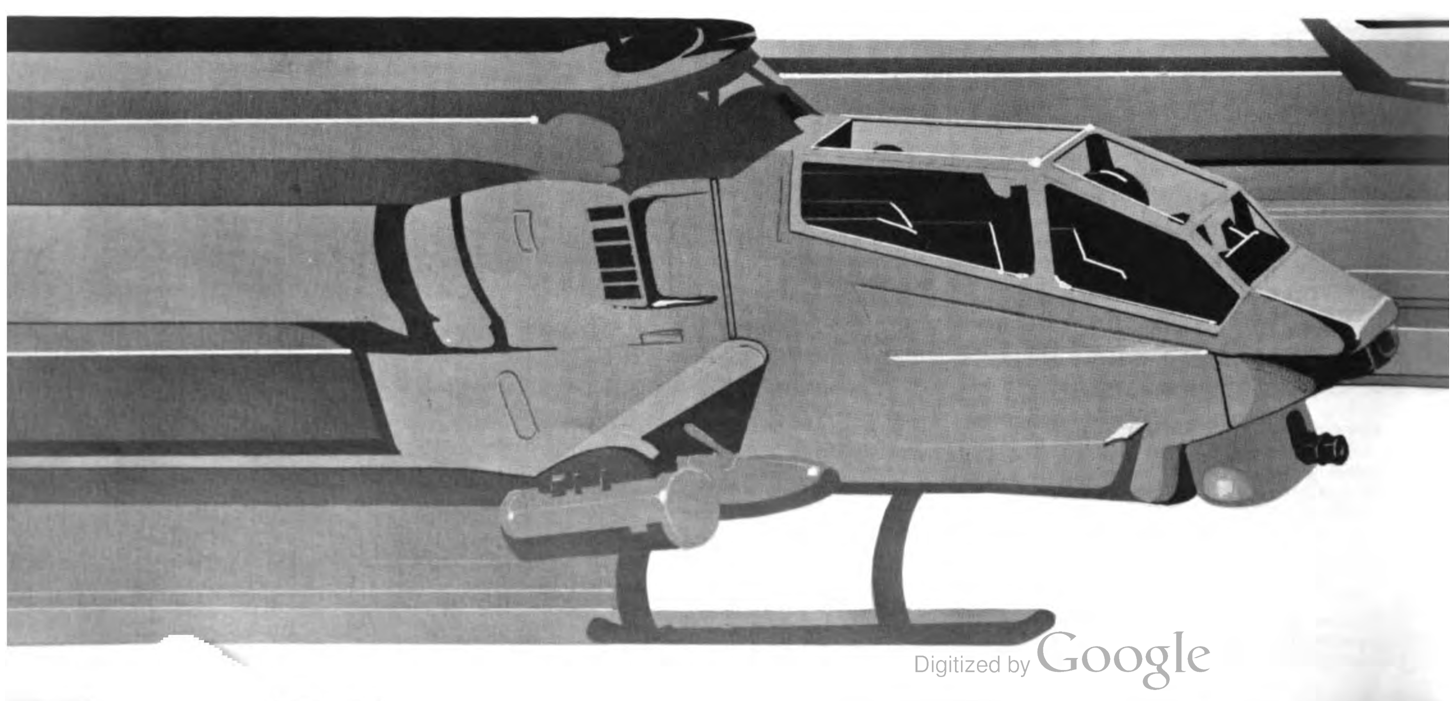
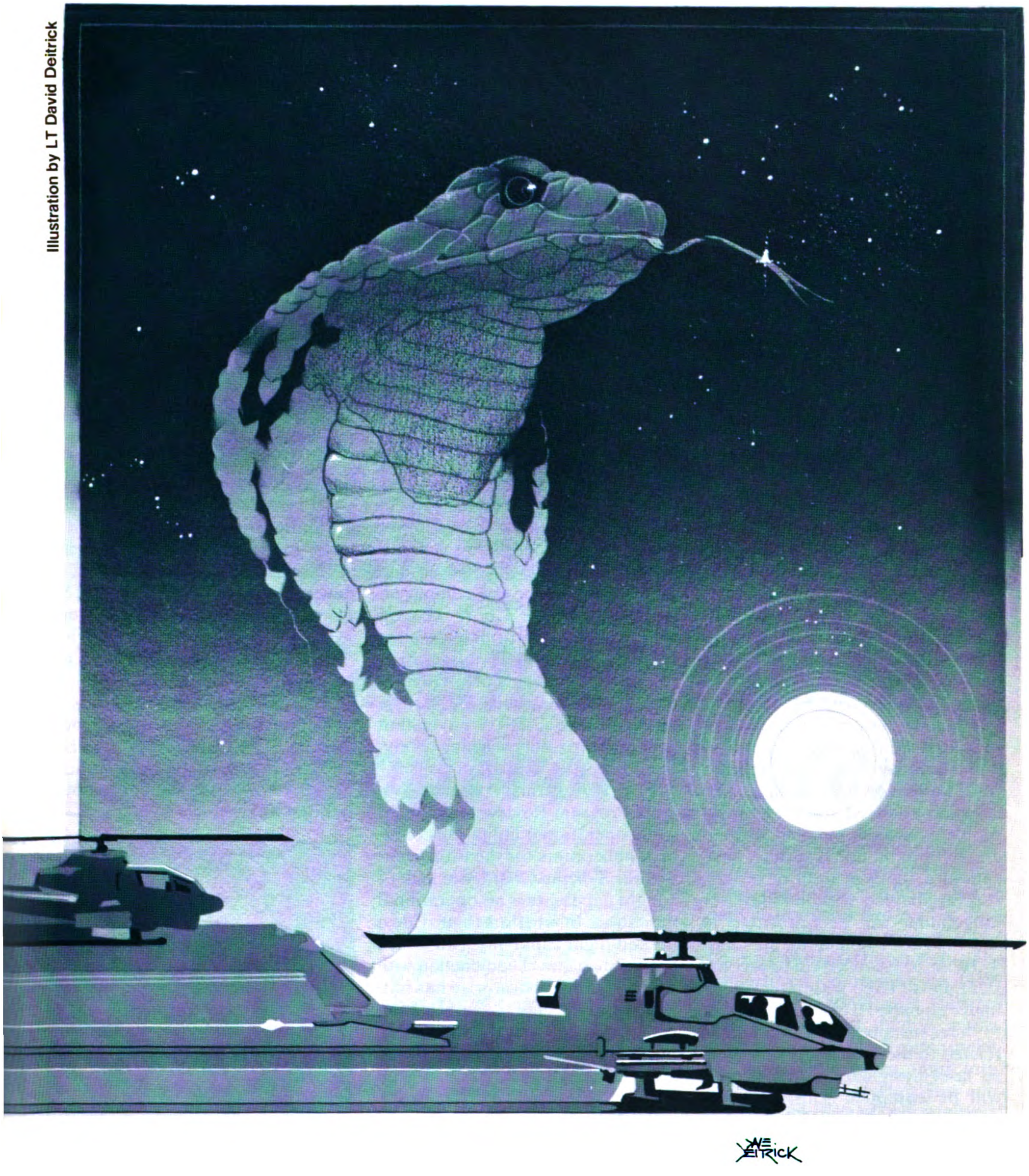
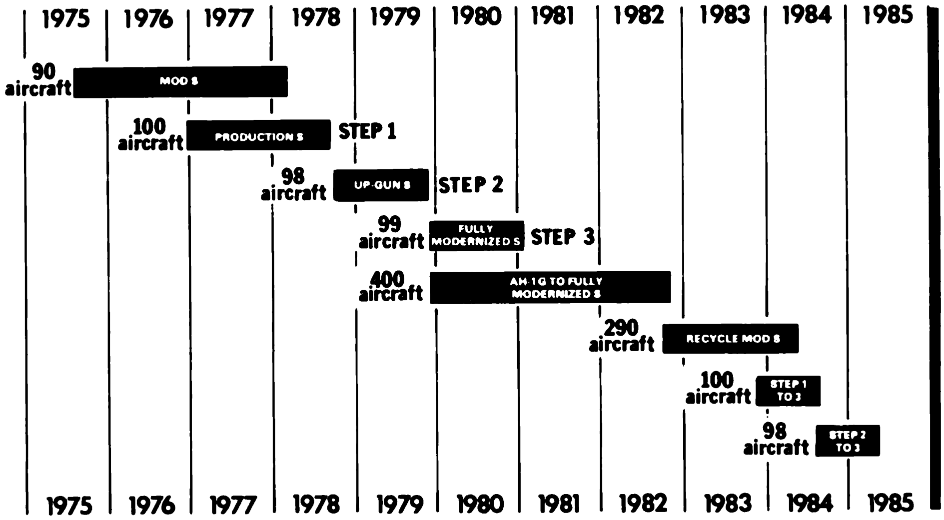


Illustration by LT David Deitrick



Cobra have been extremely encouraging, surpassing our expectations, particularly the deadly accuracy being achieved with the 20 mm cannon. Development testing (DT) began in July with operational testing (OT) scheduled to follow this month. Completion of DT/OT testing is set for next month, when it is planned for the first fully modernized AH-1S to be delivered to the Army. Monthly meetings with



AH-1S Modernization Program Schedule

U. S. Army Missile Command, U.S. Army Armament Readiness Command, U.S. Army Communications and Electronics Materiel Readiness Command, U.S. Army Troop Support and Aviation Materiel Readiness Command and Bell Helicopter are being held to assure all necessary actions are taken to obtain a timely materiel release of the fully modernized AH-1S.

When the fully modernized Cobra is first fielded the laser rangefinder and airborne laser tracker (ALT) will not be installed. The laser experienced some technical problems, which, coupled with increased production leadtime, have caused a slippage until next July. Aircraft fielded without the laser rangefinder will be retrofitted in the field by exchanging standard TOW missile subsystem telescopic sight units (TSU) with laser rangefinder equipped TSU. The decision to defer installation of the ALT is related to the availability of a fielded laser designator. Each aircraft will be equipped with complete provisions so the ALT can be installed in the field at the appropriate time.

Future AH-1 Configurations. Last August a memorandum of understanding (MOU) on AH-1 configuration was established among the commanding generals of the Aviation Center, Armor Center and TSARCOM. The MOU establishes the AH-1S configuration and assures that future changes to the AH-1 will enhance the combat effectiveness of the Cobra weapon system. All three principals must agree to any future configuration changes. As a result of the agreement, action has been initiated to terminate the CONUS navigation package, proximity warning receiver and the M-130 chaff dispenser.

The 1978 Army Aviation Systems Program Review highlighted some operational limitations of attack helicopters for the future battlefield. For the Cobra, the lack of a night capability is an operational limitation. In an effort to provide a limited night capability, the Cobra project manager in conjunction with Night Vision Laboratories has initiated a feasibility demonstration program for a FLIR (forward looking infrared radar) Augmented Cobra TOW Sight (FACTS). The FACTS system will provide the copilot gunner with an improved capability to acquire and engage targets during periods of poor daylight visibility (dawn, dusk, smoke, haze, etc.) and at night.

The feasibility demonstration program is ongoing with the objective to demonstrate the improved AH-1S adverse weather target acquisition capabilities and to form a basis for a required operational capability change in support of a development program for FACTS. Contractor tests conducted in August were completely successful. Five TOW missiles were fired and all missiles hit the target.

The Cobra TOW program is a vital one for the defense of our country. The Cobra team is working hard to provide the best attack helicopter weapon system for our fighting force now!

COL Pershing entered the Army in 1954 after being graduated from Purdue University in West Lafayette, IN. He earned a master's degree in Business Administration from Michigan State University, East Lansing, and is a graduate of the Army War College

Figure 1

Modernized Cobra Fire Control System

George L. Cohill
Manager, Systems Integration
Bell Helicopter Textron
Ft. Worth, TX

THE MODERNIZED AH-1S Cobra is the result of a series of evolutionary changes responding to a changing battlefield environment. When the AH-1G was introduced to combat in 1967 the target array primarily was trucks, troops and sampans. The AH-1G's rockets and turreted 7.62 mm miniguns could be used at close ranges and at altitudes of 1,000 to 2,000 feet with good effect and relative immunity from the unsophisticated air defense capabilities of the enemy. A simple airspeed based jump correction and eyeball estimated range correction were sufficient for getting turreted gunfire near the short range targets and the fire was then walked onto the target.

For rocket delivery a manually preset combining sight was used along with the tactic of making a shallow dive at the target. These "canned maneuvers" were practiced until some of the old hands became proficient at delivering rockets under a particular set of conditions.

The battlefield of today, dominated by armor accompanied by sophisticated air defense capabilities, requires a gunship able to deliver accurate fire on the first burst at standoff ranges while flying nap-of-the-earth. The modernized Cobra with its TOW missile system, 20 mm turreted gun, remote set fuzing multi-function rocket warheads, rocket management system, and integrated gun and rocket fire control system (figure 1) is equipped to respond to the demands of this new, more sophisticated battlefield environment. The addition of the TOW missile system (figure 2) to the AH-1G in 1972 gave the capability to

deal with the armor threat of the modern battlefield.

In the spring of 1978 the universal turret subsystem with its 20 mm automatic cannon was qualified on the AH-1S (see page 34, figure 3, this issue). As part of the same program the addition of the rocket management subsystem (page 38, figure 7) gives the AH-1S pilot the capability to manage the inventory of as many as 76 rockets of five different types, to select and fire them at various rates and to remotely set the RC fuzing system in the rockets.

The stabilized telescopic sight unit from the TOW missile system can be used to aim the turreted 20 mm gun. The AH-1S, therefore, had all of the elements for aiming and firing the 20 mm cannon at standoff ranges, but did not have a fire control system to provide the necessary lead angle and super elevation corrections to make the gunfire system adequately accurate at those ranges. The same was true of the rocket system. The manual techniques used in Vietnam were totally inadequate to handle the problem of firing rockets from nap-of-the-earth, at hover and low air speeds, and out to ranges of 6,000 meters with sufficient accuracy to make the weapon effective.

Studies conducted at Bell Helicopter Textron and tests conducted by the Army had shown that gunfire and rocket fire accuracy could be improved by factors of two to five by the addition of a full solution fire control system. During the fall of 1976 BHT performed detailed systems studies and prepared a set of specifications for a laser rangefinder, an omnidirectional air data system, a head-up display and a digital fire control computer. In the spring of 1977 Bell conducted a competition and source selection for the four major elements of the fire control subsystem. These major subsystems were integrated by BHT with the TOW missile system, the XM-128 helmet sight subsystem, the AN/ASN-128 lightweight doppler navigation subsystem, the airborne laser tracker, the rocket management subsystem, the universal turret subsystem, and several other onboard subsystems to provide a full solution fire control subsystem for the AH-1S. A functional block diagram of the fire control subsystem is shown in figure 3.

In the subsequent paragraphs the fire control system is described in terms of a few of its primary modes of operation. Highest accuracy gunfire is achieved using the TSU for target acquisition and tracking. In this mode the gunner tracks the target with the TSU and obtains accurate laser range to the target by means of the TSU mounted laser rangefinder. The universal gun turret is connected to the TSU through the interface control unit. In the absence of gunline commands from the fire control computer, the gun turret points at the same target that the TSU is tracking. The fire

Glossary

AADS	airspeed and direction sensor
ADS	air data subsystem
BHT	Bell Helicopter Textron
CRT	cathode ray tube
DC	direct current
EPU	electronics processor unit
FCC	fire control computer
FLIR	forward looking infrared
HUD	head-up display
HUDS	head-up display system
H_z	hertz
LAAT	laser augmented airborne TOW
LAI	low airspeed indicator
LOS	line-of-sight
mm	millimeter
mrad	milliradians
MTBF	mean time between failure
RC	recent capacitance
RMS	rocket management system
TOW	tube-launched, optically-tracked, wire-guided
TSU	telescopic sight unit
TTL-MSI	transient transient logic—medium scale integration
V	volt
VA	voltampere
W	watt

Figure 2
TOW Missile System Components

control computer takes in line-of-sight angles, line-of-sight angle rates and range data from the TSU; air data (three dimensional airspeed, static pressure and air temperature) from the air data set; three dimensional aircraft ground speed from the doppler; and aircraft pitch and roll angles with respect to the local vertical from the vertical gyro.

With the range and LOS rate data and doppler velocity data, the computer generates an estimate of target ground velocity and aircraft ground speed. Wind speed is computed by combining doppler velocities and vector airspeed from the air data set. Air density is computed from the static pressure and temperature data.

All of the preceding parameters are combined by the computer in a set of ballistic equations to compute azimuth and elevation offset angles by which the gun turret must be displaced from the line-of-sight to the target in order for the bullets to hit the target. Boresight corrections which are stored in the fire control computer are added automatically to the azimuth and elevation offsets to account for boresight errors.

The final azimuth and elevation offset angles are updated at a 50 Hz rate and added to gun lines displacing the gun turret from the TSU line-of-sight by a corresponding amount. When the gunner pulls the trigger the cannon fires a burst of 20 mm rounds at a 730-shot per minute rate. The projectiles should intercept the target at the point where the target will be when the projectiles arrive. In the fire control solution the computer has accounted for range, projectile ballistics, aircraft to target geometry, aircraft attitude, aircraft motion, angles of attack and sideslip, wind, air density, target motion and weapon system boresight error.

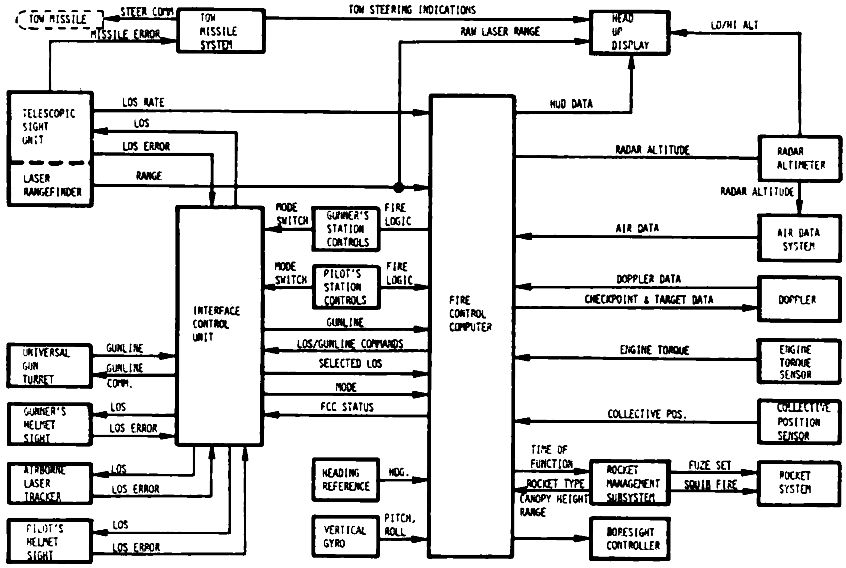


Figure 3

Modernized Cobra Fire Control Subsystem

Either crewmember can use the helmet mounted sight to direct gunfire. In this mode accurate LOS angle rate information is not available and manually estimated range is used, but the fire control solution accounts for all of the other variables listed above. The helmet mounted sight directed gunfire mode is not as accurate as the TSU directed mode, but since the helmet sights are used for snap shooting at close-in targets, high accuracy is not required.

There are two basic modes of rocket delivery, direct and indirect. In both modes the pilot uses the head-up display as the primary sighting system. In the direct mode the fire control computer takes in range information from either the laser rangefinder or manually set range on the rocket management panel; the type of rocket selected by the pilot on the RMS panel; and collective position for downwash computation; in addition to the inputs (other than LOS and LOS rate) used for gunfire.

The fire control computer calculates a solution to the rocket delivery problem and positions the HUD fire control reticle in azimuth and elevation. The pilot then maneuvers the aircraft in a way such that the reticle superimposes on the target and punches off the rockets. Based upon the rocket and penetration mode selected by the pilot the computer also computes a time of function or a penetration delay for the fuze.

The indirect rocket delivery mode uses the TSU as the target acquisition and tracking sensor. The HUD is used as if it were an ordinary cathode ray tube type display as opposed to a see-through combining sight. Under certain conditions such as long ranges (more than 4,800 meters) it is necessary to elevate the nose of the Cobra so much that it actually interferes with the pilot's line-of-sight to the target.

Figure 4
Head-Up Display Subsystem

Under these conditions the pilot cannot superimpose the fire control reticle on the target which must be done in the direct mode. The pilot, therefore, switches to the indirect mode and has the gunner track and range on the target. The LOS and range data from the TSU is combined by the computer with the other parameters described above and the fire control reticle is displaced by the appropriate amount. Pilots then fly the aircraft in a way such that the fire control reticle is superimposed on the aircraft boresight reference symbol. When the two symbols are superimposed the pilot fires the rockets which should strike the target which cannot be seen from the cockpit. The indirect mode can be used at shorter ranges as well, if the crew prefers it to the direct mode.

As stated, four major subsystems were added to the AH-1S to provide an accurate full solution gun and rocket fire control system. Each of these subsystems is described in more detail below.

The **head-up display subsystem** presents pilots the collimated symbology they require to align the aircraft for TOW missile delivery, to aim the aircraft for rocket firing, and to monitor certain critical flight parameters without diverting attention from the target scene. The HUDS (figure 4) consists of three line replaceable units, a pilot's display unit called a HUD, a symbol processor unit, and a boresightable mount.

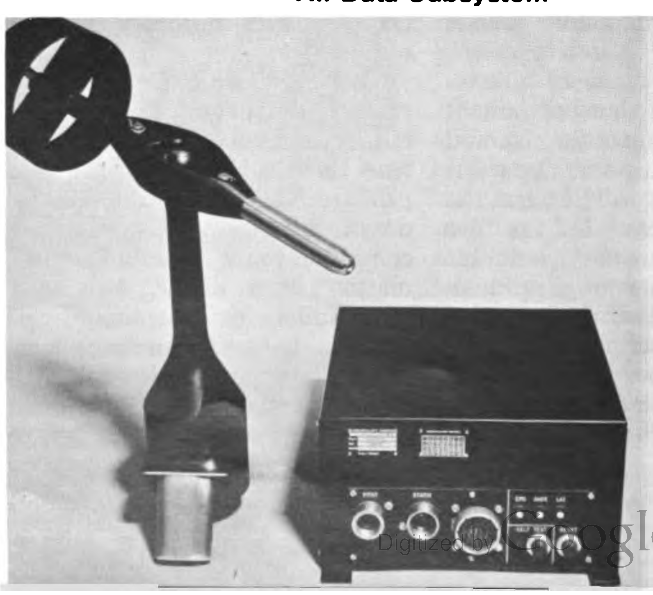
The HUD is mounted on top of the pilot's instrument panel and presents flight, target acquisition and weapon delivery information using a CRT/optical display. An optically-coated glass, dual combiner is used to reflect the symbology which is generated by the CRT into the central 20 degrees of the pilot's forward field of vision. The symbology which appears in the pilot's field of view is focused at infinity giving pilots essential information that they can view simultaneously with the target, without constantly refocusing their eyes and scanning a multitude of panel instruments during target attack. Weapons systems, fire control, flight status and flight control information are displayed, including target acquisition reticles, aircraft boresight reference, and gunner's sighting cues. The fire control data displayed includes aiming and firing data for rockets and TOW missiles and is based upon the weapon type selected by the crew. Also displayed are engine torque, radar altitude, magnetic heading and target range data information.

The symbol processor receives and processes inputs from the fire control computer and other aircraft sensors and generates all of the symbology which is displayed on the HUD.

The boresightable mount, which becomes a permanent part of the ship after boresighting, permits complete interchangeability of the HUD at the unit maintenance level without the need for reboresighting.

The head-up display subsystem is a compact, lightweight

Figure 5
Air Data Subsystem



system weighing 26 pounds. The HUDS is constructed of modules for quick replacement when maintenance is required. The current estimated MTBF is nearly 1,500 hours.

Brightness of the display can be adjusted to be compatible with night vision goggles for nighttime use. The addition of the head-up display subsystem to the modernized Cobra, with its ability to represent instant weapon delivery and flight information, significantly enhances the 24-hour mission effectiveness of the Cobra weapon system.

Accurate air data is essential for both gun and rocket fire control. This information is provided to the fire control system by the **air data subsystem.** The ADS is shown in figure 5. The air data subsystem consists of three line replaceable units: The airspeed and direction sensor (AADS), the electronics processor unit (EPU) and the low airspeed indicator (LAI). Each line replaceable unit is replaceable without any adjustment to other subsystem units.

The airspeed and direction sensor is a swivelling pitot-static probe, which senses local airflow pitot and static pressures, the angles of that airflow relative to the helicopter, and the free stream air temperature. Pneumatic pressure outputs and electronic signals for angles and temperature are fed to the EPU.

The EPU converts pneumatic pressure information to analog signals through electrical force balance pressure transducers. These pressure signals are combined with angle and temperature data by a microprocessor based computing unit. Output signals from the EPU are in the form of analog and digital formats that interface with the fire control computer (FCC), the radar altimeter and the LAI.

The low airspeed indicator is a standard 3-inch indicator which displays forward and lateral components of airspeed up to 50 knots in any direction. Digital signals are available to the FCC for forward velocities up to 223 knots.

Total subsystem power consumption is less than 25W from the aircraft 28V DC supply, and less than 200 VA from the aircraft 115V 400 Hz supply for AADS anti-icing. The subsystem weighs less than 10.5 pounds.

The single most important fire control parameter that was not available on the basic AH-1S was accurate target range data. This is especially true at the longer effective range of the 20 mm cannon. Accurate range data also is required to permit the full use of the standoff range capability of the TOW missile system. In the modernized AH-1S accurate range information is provided by a neodymium **laser rangefinder** which is integrated into the telescopic sight unit of the airborne TOW system (figure 6). This modified system is known as the laser augmented airborne TOW system. An engineering drawing giving details and identification of parts may be seen

Figure 6
Laser Augmented Airborne TOW

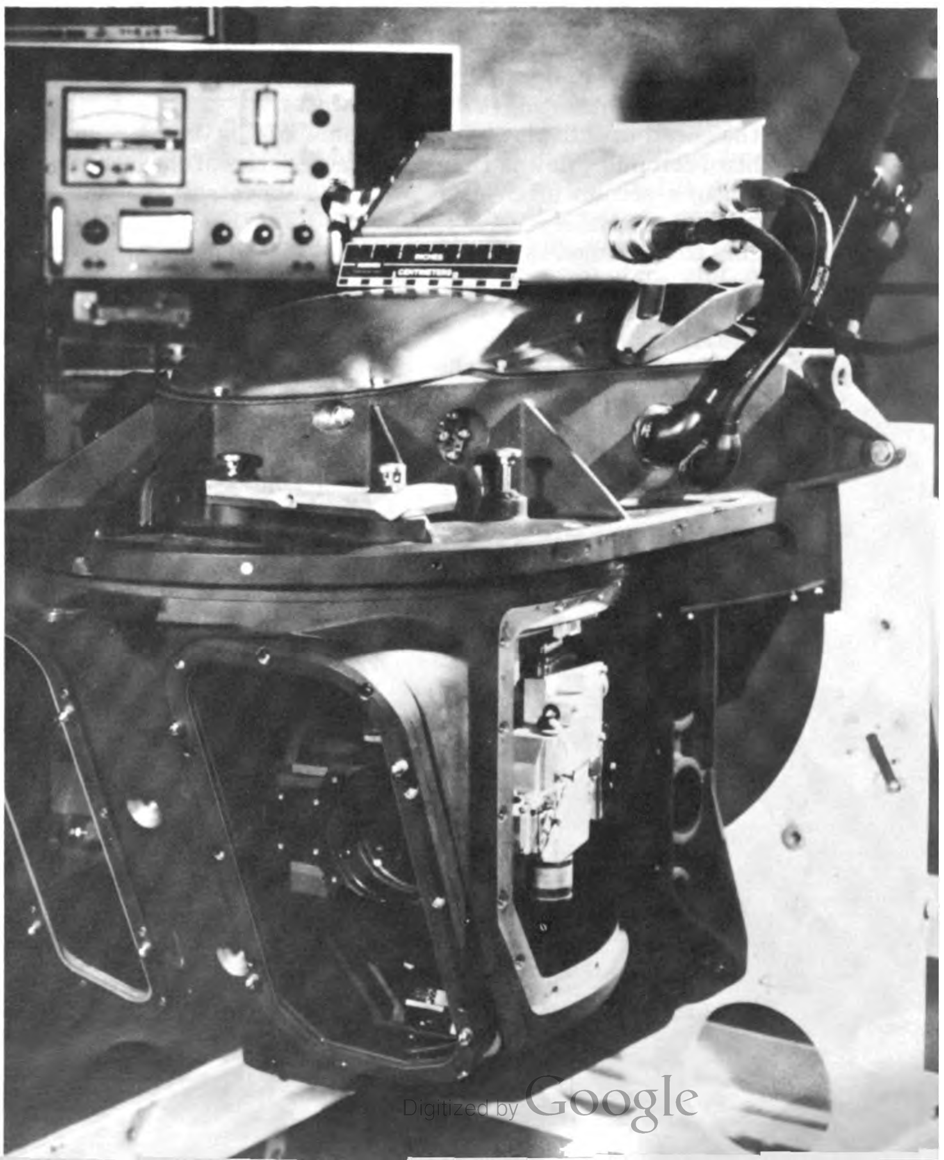


Figure 7

Characteristics of Laser Rangefinder Subsystem

TRANSMITTER	
Laser medium	Neodymium YAG
Switching	dye Q
Wavelength	1.06 μm
Beam divergence	80% in 0.5 mrad
RECEIVER	
Detector type	silicon avalanche
Max range	9900 meters
Instantaneous FOV	2 mrad ±10%

on page 42, figure 6, this issue.

The laser provides four digit range values through the TSU eyepiece to the gunner and digitized serial data ranges to both the head-up display and fire control computer in less than a quarter of a second after laser trigger closure. The laser is capable of ranging to 9,900 meters. Multiple targets can be discriminated, and the gunner is provided with multiple target indication.

As shown in figure 6 the system hardware consists of a transmitter, receiver and display mounted within the sight and an electronics box mounted on top of the TSU. Complete integration is accomplished at a weight penalty of 18 pounds and a power dissipation of less than 200 watts.

Some of the more important characteristics of the laser rangefinder subsystem are listed in figure 7.

Another feature which was included was a capability to establish a minimum range gate. The gunner can adjust this gate and exclude laser returns nearer than the gate value, such as trees in front of a target.

The modernized Cobra fire control system is tied together by the digital **fire control computer**. The FCC is shown in figure 8. The small cylinder shown in front of the unit is the boresight memory module which permits boresight data to be transferred from the FCC in the Cobra to a replacement FCC if the computer fails. Thus it is not necessary to reboresight the system when the computer is replaced.

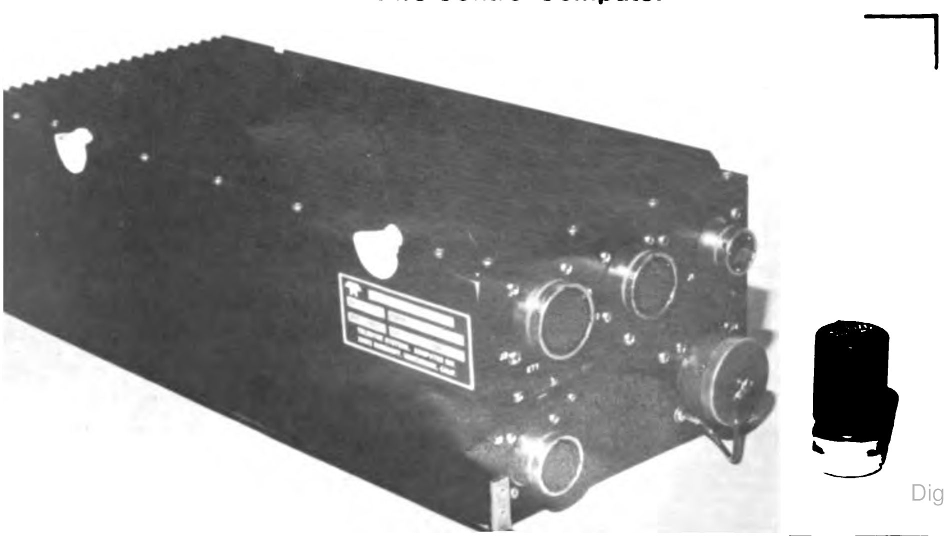
The modernized Cobra fire control computer is a 16 bit, parallel general purpose digital computer. It has evolved from the Teledyne TDY-43 family of aerospace minicomputers. The computer is mature equipment using TTL-MSI components as the primary technology base. The FCC interfaces with all of the weapon, sighting and sensor subsystems on the helicopter to provide multimode fire control solutions. The crew makes mode and weapon selections through the cockpit controls and the FCC provides coordination between sights, sights and sensors, and sights and weapons.

The multifunction operation of the FCC includes the following:

- Solves ballistic equations for eight types of 2.75 rocket and 20 mm rounds providing rocket launch line and gun prediction angle based on instantaneous atmospheric, range and target-helicopter velocity conditions.
- Performs control and switching for the various system modes of operation and establishes priorities.
- Generates drive signals for head-up display symbology.
- Performs self test, interface test and provides fault indications.
- Performs required computations to support the fire control solutions.
- Stores boresight transformation matrices for electronic boresight corrections between weapons, sights and sensors.

Figure 8

Fire Control Computer



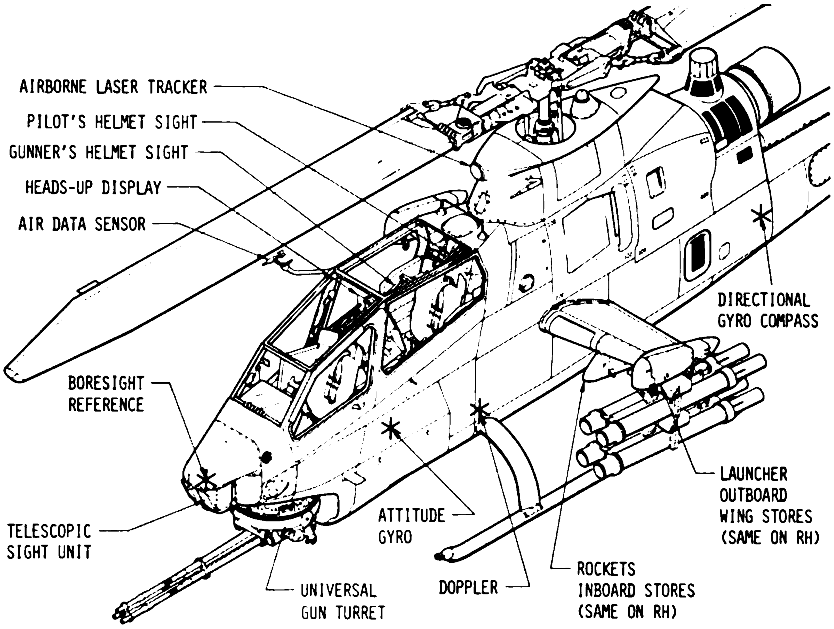


Figure 9

Components Requiring Boresighting

The FCC provides ballistic solutions at a rate of 50 times per second.

The FCC is capable of 420,000 operations per second using a standard mix of instructions and has a memory capacity of 8,192 words installed and 8,192 words additional growth capability on the same memory card. Using spare card spaces for additional memory the growth capability is 49,152 words. The present operational program occupies 7,900 words of memory leaving more than 100 percent growth capability without adding cards, and the 50 Hz fire control solution rate consumes .60 seconds per second of operating time leaving time for 66.7 percent growth in the operational program.

The modernized Cobra gun and rocket subsystem is capable of delivering highly accurate long range gun and rocket fire. For this capability to be realized, however, the elements of the armament and fire control system must be precisely aligned with each other. The process of bringing all of the elements of the system into alignment is referred to as boresighting. In figure 9 the components requiring boresighting are identified. The orientation of each of these components must be mechanically aligned and/or electronically compensated with respect to the aircraft reference (on top of the TOW telescopic sight unit) to accuracies ranging from 0.25 degree down to 0.015 degree.

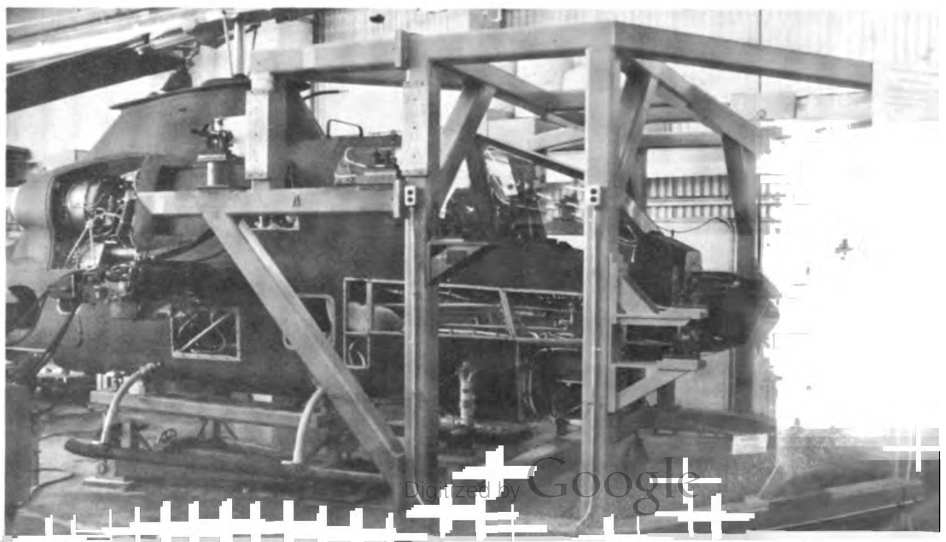
This kind of precision is accomplished in the factory during assembly of the AH-1S by means of highly accurate assembly jigs and a large, rigid boresight fixture with high precision optical telescopes and collimators. The factory boresight fixture is shown in figure 10.

It is easy to see that a boresight fixture as large and heavy as the factory fixture is not practical for application in the field. BHT, therefore, undertook the design of a boresight fixture capable of providing the required alignment accuracies but more suitable to field use. A prototype field portable boresight fixture is shown mounted on the nose of an AH-1S in figure 11. This unit provides the same basic functions as the factory boresight fixture. The boresight fixture is used with standard Army elbow borescopes and a new unit called the boresight controller (figure 12).

The boresight controller is electrically connected to the fire control computer, and permits the aircraft armament repairman to use the fire control computer to assist in boresighting the system. This is one of the major features of the new fire control system for the AH-1S. The fire control computer automatically compensates for boresight errors

Figure 10

Factory Boresight Fixture



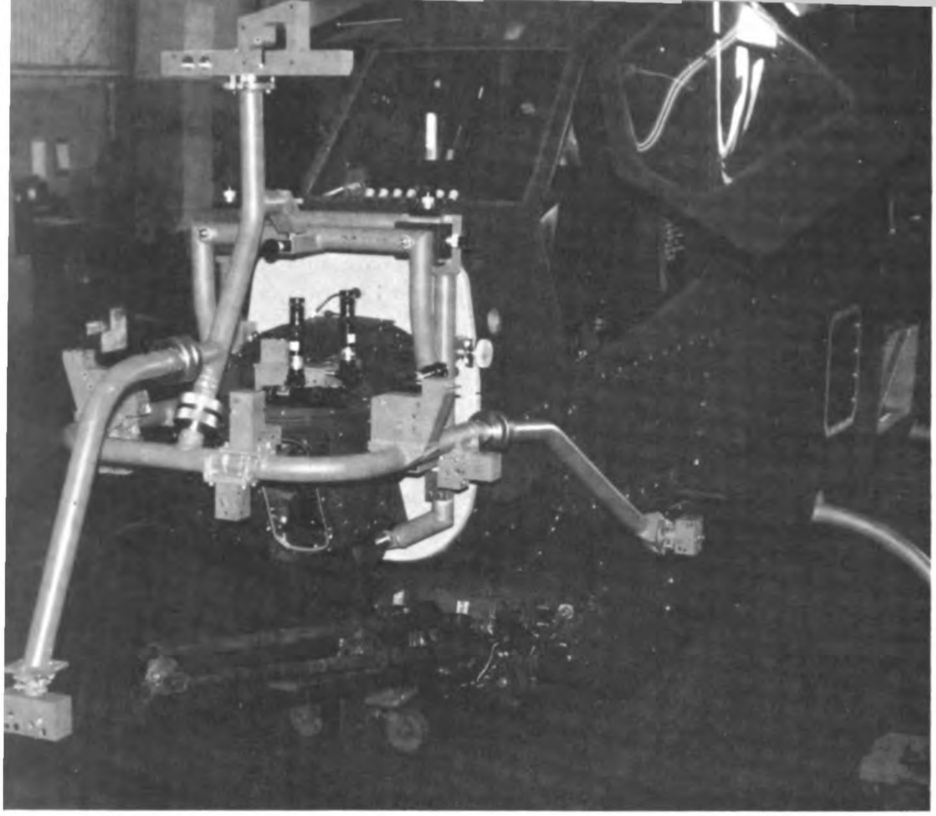


Figure 11
Prototype Field Boresight Fixture

among the armament and fire control components by storing these errors during boresighting and then incorporating boresight corrections dynamically into the fire control solution during actual firing of the weapon.

The boresight concept for the modernized Cobra armament and fire control system has been developed with careful consideration given to the problems of maintaining and replacing components in the field. If it is necessary to replace the telescopic sight unit, the system must be reboresighted. The head-up display unit, the air data sensor and the fire control computer can be replaced without reboresighting. The boresight correction data that is stored in the fire control computer is contained in a small module on the front panel of the computer. This module is removed by unscrewing a finger tight connector, pulling out the boresight memory module, and transferring it to the replacement computer.

The modernized Cobra boresight kit provides a number of advantages over the approach used on the AH-1Q. Despite the much tighter accuracy requirements and the new components requiring boresighting, the new system can be boresighted in considerably less time than before. This is due primarily to the fact that in boresighting the AH-1Q it was necessary to jack up and level the aircraft and set out targets over a large clear level area, and all of the final alignments were done by means of adjustment of resolvers or mechanical means. In the modernized Cobra it is not necessary to jack up or level the aircraft; day or night, indoors or out, any space large enough to hold the aircraft will do; no targets are required; and, finally, most of the high accuracy adjustments are eliminated because the fire control computer stores these small differences and accounts for them in the fire control solutions.

The elements of the modernized Cobra fire control subsystem were brought together for the first time in the Systems Integration Laboratory at the Bell Helicopter facility in Hurst, TX. Figure 13 shows the Cobra forward fuselage section that was used extensively in the integration testing. Each of the system components was installed in the location where it would go in the operational

Figure 12
Boresight Controller

aircraft and cable runs were made identical to those used in the aircraft. As each unit was delivered, it was functionally checked, interfaces were verified and then the units were installed and interconnected.

Then began the time-consuming task of validating and debugging the computer operational flight program and the functional interaction of the various parts of the fire control subsystem. Many interface incompatibilities, digital data channel problems and software bugs were discovered and corrected in the Systems Integration Laboratory. By the use of the integration lab it was possible to have the fire control system debugged and operating by the time the first prototype Cobra was ready. In August 1978, 13 months from the start of the development contract, the first modernized Cobra fire control system was delivered to Yuma Proving Ground, AZ for the critical issues demonstration test firing program.

In the critical issues testing at Yuma the fire control system performed exceptionally well. The 20 mm gunfire specification calls for azimuth and elevation errors less than 10 milliradians RMS required (6 milliradians RMS desired) over a spectrum of flight, range, wind and target motion conditions. Rocket test results while not as spectacular as the gunfire results show marked improvement over the results obtained without fire control. Army development testing and operational testing which are under way at the present time should provide additional data to further refine the test results.

Bell Helicopter Textron's modernized AH-1S is the free world's first production attack helicopter with a completely integrated full fire control capability. All the new components contribute to impressive weapons accuracies never before achieved in a production helicopter. The AH-1S will continue to be the front line antiarmor aircraft for 20 or more years. To capitalize on the effective fire control system, a night capability can be added. The first phase of examining this improvement was completed in August 1979 when a FLIR TOW night sight was used to guide missiles to target impact during a pitch black night. Other improvements are under consideration. The modern fire control is one important step in keeping the AH-1S up to date.

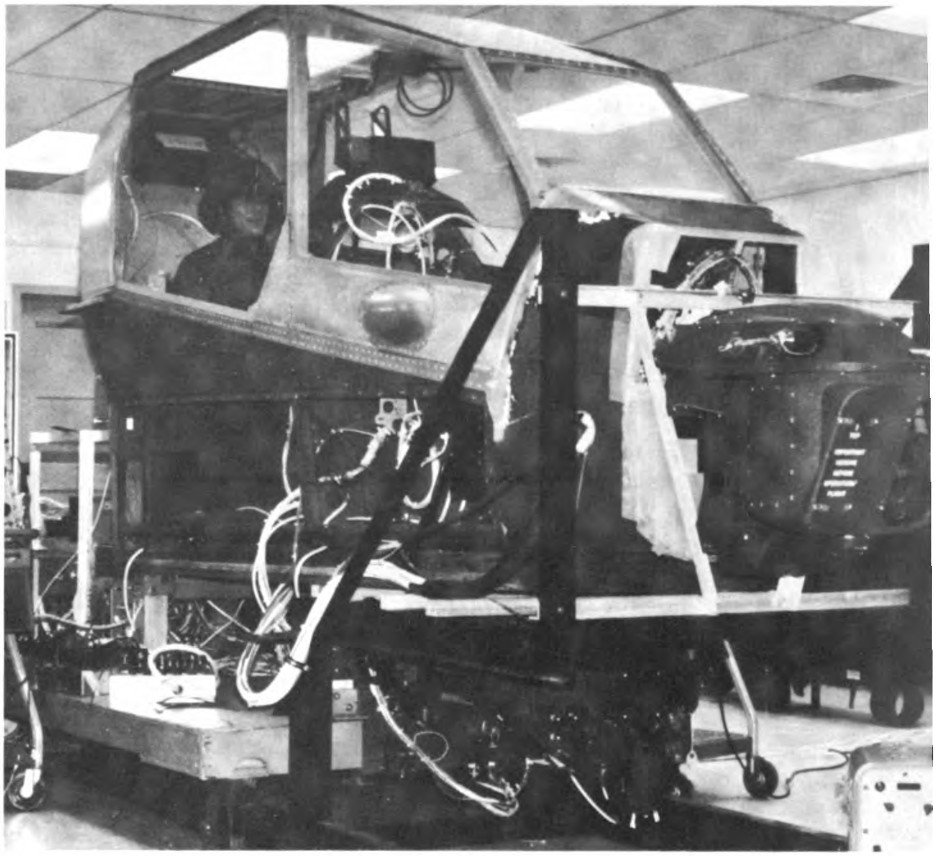


Figure 13

Systems Integration Laboratory Cobra Forward Fuselage Section

Mr. George L. Cohill

CURRENT AH-1 EVOLUTION PLAN

290	100	98	99
MODERNIZED AH-1S	PRODUCTION AH-1S	UP-GUN AH-1S	MODERNIZED AH-1S
Modified from existing AH-1Gs	Low glint canopy New instruments New blade at #149 Radar warning CONUS Nav radios RAM improvements	20mm cannon Stores management 10 KVA alternator	Laser rangefinder Laser detector New fire control IR jammer New IR suppressor Doppler Nav New transponder and secure voice

Figure 1

MODERNIZED

FIELDING THE AH-1S Cobra TOW antiarmor attack helicopter to operational units has been a tremendous success. The combination of proven technology, coordinated management and professional introduction speaks for itself. This new helicopter has been demonstrated to several European countries and at the Paris Air Show. In each case, its capabilities have generated enthusiastic aviator response and positive command interest.

The first ship of the 297 new production aircraft was delivered to the Army in March 1977, with final delivery scheduled for February 1981. As these new helicopters are delivered from the production line, they will be issued initially to FORSCOM CONUS units. This fielding began in August 1977 at Fort Bragg, NC with the assignment of aircraft to the 82d Airborne Division.

This article, the first of a three-part series, addresses the scope of the Cobra program and highlights the improvements that have been or will be accomplished within the next few years to modernize fully the AH-1S Cobra TOW antiarmor attack helicopter. The second and third parts of this series will cover the new turret and weapons programs and the fire control, aircraft survivability and laser rangefinder/tracker programs, respectively.

MODERNIZATION ACCOMPLISHED IN PHASES: Improvements to the AH-1S new production aircraft will be accomplished through phased product improvement programs. The configuration changes and phasing for the Cobra fleet evolution to modernized AH-1S is summarized in figure 1. The first 100 aircraft produced will feature a new canopy and cockpit, a new T703 engine, uprated transmission plus im-

GLOSSARY

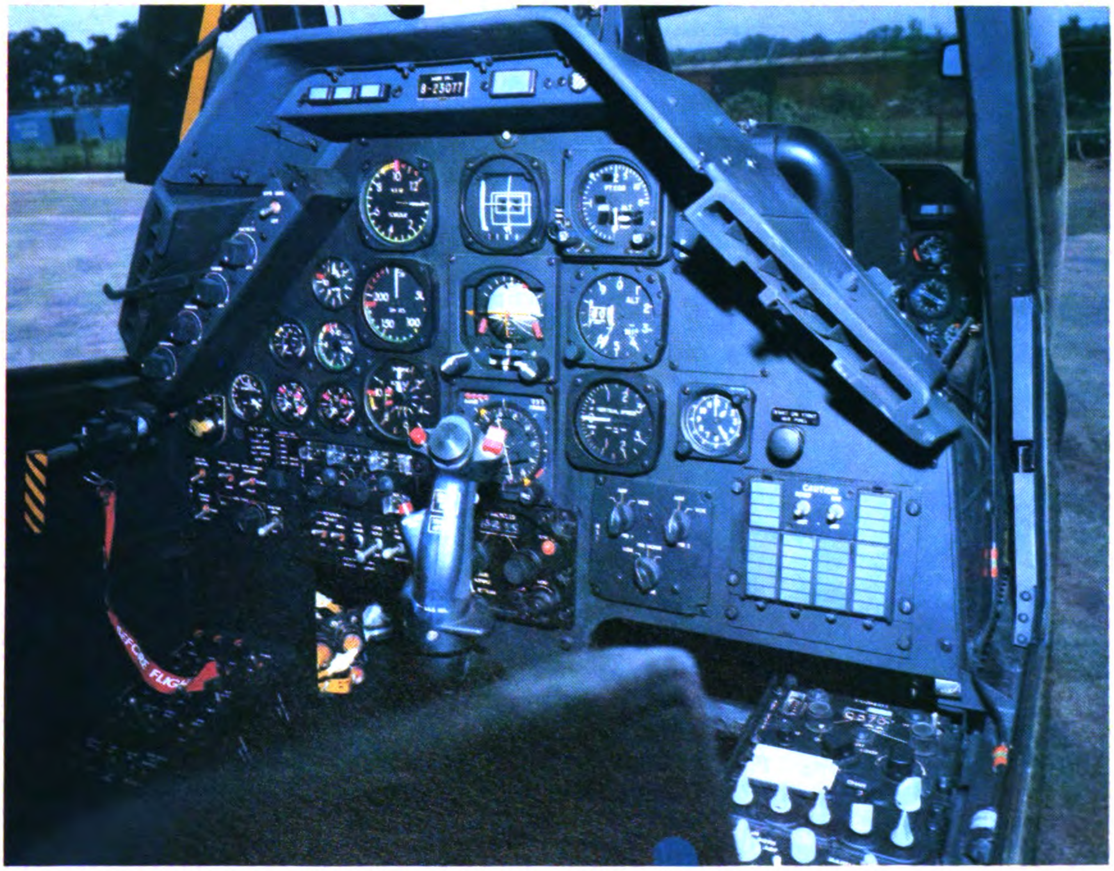
ADF	automatic direction finder
AM	amplitude modulation
CONUS	Continental United States
ECU	environmental control unit
FM	frequency modulated
FORSCOM	Forces Command
HSI	horizontal situation indicator
IFR	instrument flight rules
ILS	instrument landing system
KHz	kilohertz
MHz	megahertz
NOE	nap-of-the-earth
NVG	night vision goggles
RAM	reliability, availability and maintainability
SLAE	standard lightweight avionics equipment
TOW	tube-launched, optically-tracked, wire-guided
TSU	telescopic sight unit
UHF	ultra high frequency
VHF	very high frequency
VOR	VHF omnidirectional range
VSI	vertical situation indicator

Figure 2 — AH-1S new production Cobra with IR paint

COBRA

Colonel Jay W. Pershing
Project Manager, Cobra, TSARCOM
St. Louis, MO

Figure 3 — pilot station instrument panel and consoles



proved survivability design features and reliability, availability and maintainability (RAM) characteristics.

Figure 2 is the new production AH-1S Enhanced Cobra Armament System (ECAS) configured Cobra. The new improved main rotor blade developed by Kaman Aerospace Corporation was installed in April 1979 on the 149th production helicopter. The Air Cavalry Troop at Ft. Bliss, TX received the first AH-1Ss with this new improved main rotor blade. A new wing stores (2.75 mm rocket) management subsystem and a universal turret capable of accepting 20 or 30 mm weapons was cut into the production line in September 1978 with the delivery of the 101st aircraft. A new fire control subsystem consisting of laser rangefinder, ballistic computer, low airspeed sensor and a heads-up display will be installed on the 199th aircraft which is scheduled to be delivered in November 1979.

CANOPY AND INSTRUMENT PANELS: The production AH-1S model has a new outward appearance with its nearly flat canopy. This canopy has seven planes of viewing surfaces designed to decrease the glint signature and reduce the probability of visual detection during NOE flight. Another advantage of the new canopy is additional headroom for the pilot's visibility in NOE flight.

The cockpits of both the pilot and copilot/gunner have been redesigned with a new instrument panel to provide for crew efficiency during NOE and IFR flight. Figure 3 is the pilot's new instrument panel. The major improvement in this panel is the grouping and the size of the instruments. The torque meter, pilot steering indicator and radar altimeter are the primary tactical instruments used by the pilot to accomplish the antiarmor mission. These three instruments are located in the center of the panel, under the glare shield, and are 3-inch diameter in size. They facilitiate NOE flight and maneuvering of the helicopter into position for firing the TOW missile and keeping it within maneuver limits until missile impact.

Flight instruments are arranged in a standard IFR "T" configuration comprised of 4-inch diameter VSI and HSI grouped with 3-inch airspeed, altitude and vertical speed indicators. The number of engine instruments is reduced by using dual scale 2-inch instruments where possible. All instruments are equipped with wedge glass to distribute red lighting evenly over the instrument. The dial range markings, numerals and letters are designed to be readable under extremely low light red illumination and when using night vision goggles.

The instrument lighting switches are located on the left side of the panel and provide selective illumination of related instruments for engine, flight, tactical and console groups. The light intensity is rheostat controllable and a toggle switch is provided to the pilot and copilot for returning lighting to the panel if the NVG lights malfunction.

NEW INSTRUMENT CAPABILITY: In addition to the grouping of the instruments on the panel, there are several new instruments that have been added to improve the effectiveness of the AH-1S helicopter. The *radar altimeter*, one of the three primary tactical instruments, provides the crew the ability to fly safely at NOE during periods of poor visibility. The APR-39 radar warning receiver — a survivability improvement — is simple and lightweight, capable of being used during low level and NOE operations. This device provides the pilot sufficient warning in time to take evasive action before receiving fire from radar directed enemy antiaircraft weapons. This warning is provided through an audio and a visual display in the form of a strobe line on a cathode ra[y t]ube.

HSI and VSI. These two instruments provide a system that makes precision IFR flight and ILS, VOR and ADF approaches as natural in helicopters as it has become in fixed wing aircraft. Growth capability has been incorporated for future navigation systems such as doppler and flight director computers.

Copilot Panel. Figure 4 on the facing page shows the arrangement of the instruments used by the copilot/gunner. These flight instruments also are grouped in a standard IFR "T" configuration located on the right side of the panel and are all 3-inch diameter in size. A standby magnetic compass is mounted above and on the right side on the copilot/gunner panel glare shield. All of these instruments are marked and lighted as the pilot's. The eyepiece for the TSU is in the center of the cockpit and is used by the copilot to locate the target and guide the missile on to the target during the firing sequence.

An ECU has been redesigned for the AH-1S. The distribution ducts and plumbing for ventilating and environmentally conditioning air within the crew compartments have been modified and rerouted to adapt to the new cockpit configuration.

IMPROVED MAIN ROTOR BLADE: A new composite main rotor blade has been developed by Kaman Aerospace Corporation for use on the AH-1S. It has been designed to be used on the existing airframe without modifications to the AH-1S or its rotor system. It was installed in April 1979 on the 149th new production ECAS helicopter which was fielded at Ft. Bliss in June 1979. This new blade provides improved flight performance, survivability features and RAM, while reducing the radar cross section and acoustic detectability signatures. Figure 5 shows the new blade installation on the AH-1S new production ECAS helicopter. The chord of the blade is 30 inches wide with the outboard.

Figure 4—copilot/gunner station instrument panel and console

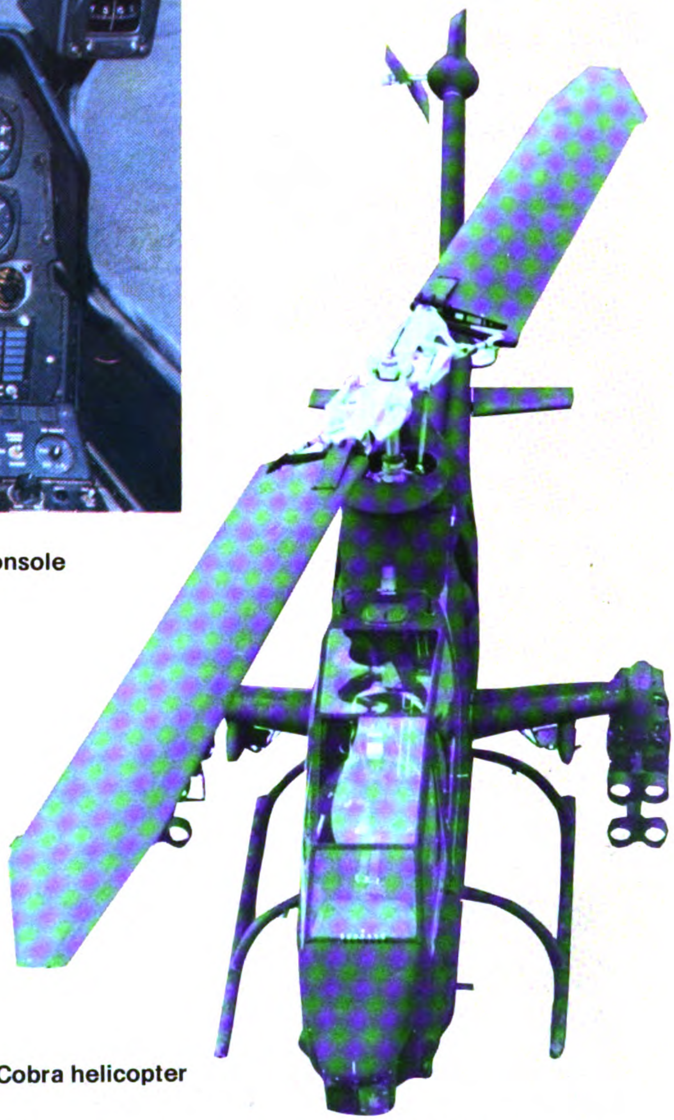


Figure 5—improved main rotor blade installed on AH-1S Cobra helicopter

15 percent tapered in both chord and thickness.

Figure 6 shows the tapering effect of the new blade and compares it to the present metal blade. The new blade has been designed for almost total repairability of the skin and core aft structure by personnel in field units. This is accomplished with the aid of a heat-pressure pack tool, shown in figure 7, which can accomplish the repair of the blade without removing it from the aircraft. A survivability feature of the new blade will allow 30 minutes of flight after being hit with a single 23 mm high explosive, incendiary, tracer round and is invulnerable to a single hit 12.7 mm round. The "through damage," which would result from this type of a ballistic hit involving both skins and the core, can be repaired by personnel in the field in less than three hours. The maximum allowable operating time for the new blade is 10,000 hours which is an increase of 9,000 hours over the present metal blade.

CANOPY ESCAPE SYSTEM: A new crew compartment escape system provides a means of escape for the pilot and copilot/gunner in emergency situations where normal egress is not possible. Operation is accomplished by a ballistic jettison system which explosively cuts the acrylic side windows from the canopy support structure while linear shaped charges and thrusters explosively

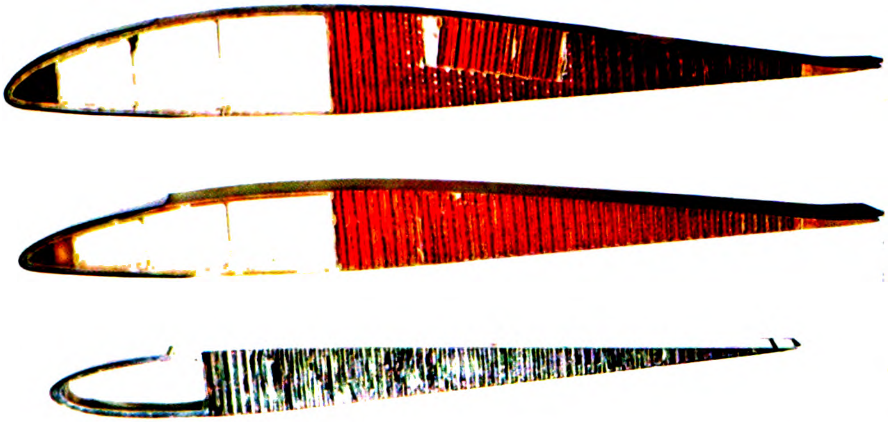


Figure 6 (Left)—inboard and outboard cross sections of improved main rotor blade (top) and outboard cross section of standard metal blade

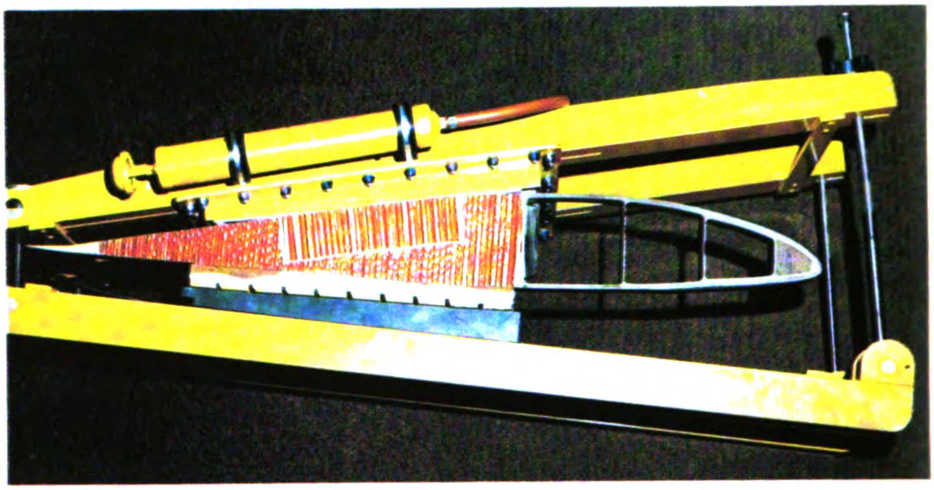


Figure 7 (Right)—heat-pressure pack special tool installed on improved main rotor blade section incorporating repair

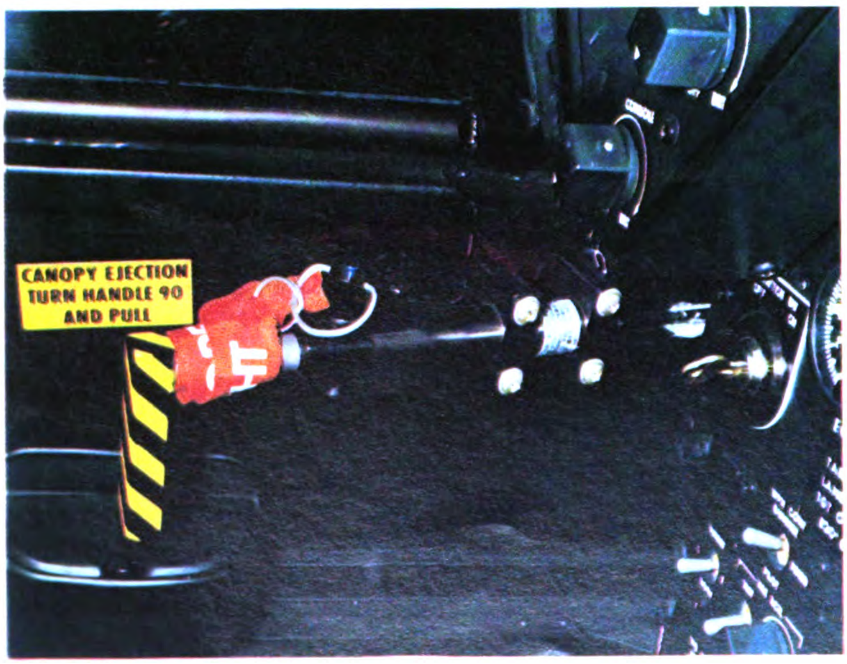


Figure 8 (Left)—arming firing handle for pilots canopy removal egress system

separate the pilot and copilot/gunner entrance doors. It is totally independent of the aircraft electrical system or of any external energy source, and can be actuated only from inside the pilot or copilot/gunner station by either of two arming/firing handle mechanisms. Figure 8 shows the canopy removal system components for the pilot station.

Other significant improvements are shown in figure 9 and include:

Hydraulic Pump. An electrically driven pump which takes the place of the collective control accumulator which provides an unlimited number of collective strokes in the event of a main hydraulic system failure. It can be used for boresighting of the turret and TOW missile subsystems without the need of additional ground support equipment (Hydraulic Mule).

Rod End Bearing. An improvement to replace current rod end bearings of the hydraulic servo cylinder connecting tubes which will increase the fatigue life of the bearings to 3,300 hours.

Tungsten Carbide Bearing Sleeves. An improvement to replace main rotor teflon feathering bearing sleeves with a more durable materiel for increasing sleeve life.

Standard Lightweight Avionics Equipment (SLAE):

- ***ARC-114 Radio*** — An FM communication radio replacing the ARC-54/131. It is a smaller, lighter radio that is compatible with secure voice systems.
- ***ARC-164 Radio*** — A UHF-AM voice communication radio replacing ARC-51. It performs all ARC-51 functions but is smaller, lighter and compatible with secure voice systems. It provides 25 KHz spacing in the 224-400 MHz band.
- ***ARC-115 Radio*** — A VHF-AM voice communication radio replacing the ARC-134. It also is compatible with secure voice systems.

CONUS/NAV (ARN-123). Improves the AH-1S navigation capability by adding VOR and ILS receivers, glide slope, marker beacon and indicator lights. The CONUS NAV package is currently included in the production AH-1S; however, future aircraft will not have this package.

Engine Deck Panels. A three piece engine deck designed to reduce bonding separations and provide for replacement of the forward and middle panels by field units. It also includes arms which support No. 1 hangar bearing.

Antitorque Controls. Provides push-pull tubes between tail rotor pedals and tail rotor pitch mechanism thus eliminating troublesome pulleys, sprockets, cables and chains. This improvement is included on the Mod "S" models.

Fire Detection. The system installed in the engine compartment includes a single loop sensing element connected to a control unit which activates fire warning indicators, located on the pilot's instrument panel.

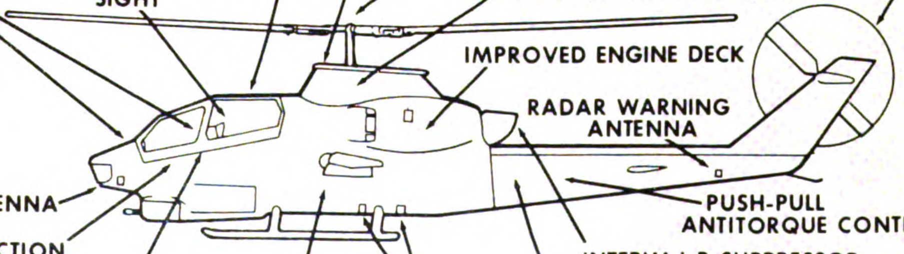
Flex Beam Tail Rotor. A simple uniball feathering bearing with a single piece hub which reduces maintenance and provides better antitorque controllability. This improvement is included on all AH-1 models.

The Cobra attack helicopter has proven itself to be a viable aircraft for today's antiarmor requirement. It also will complement the advanced attack helicopter in the high-low mix of attack helicopters in the U.S. Army fighting force of the future.

The next article on the modernization of the AH-1S will cover the new turret and weapons programs.

PRODUCTION AH-1S FEATURES

Figure 9



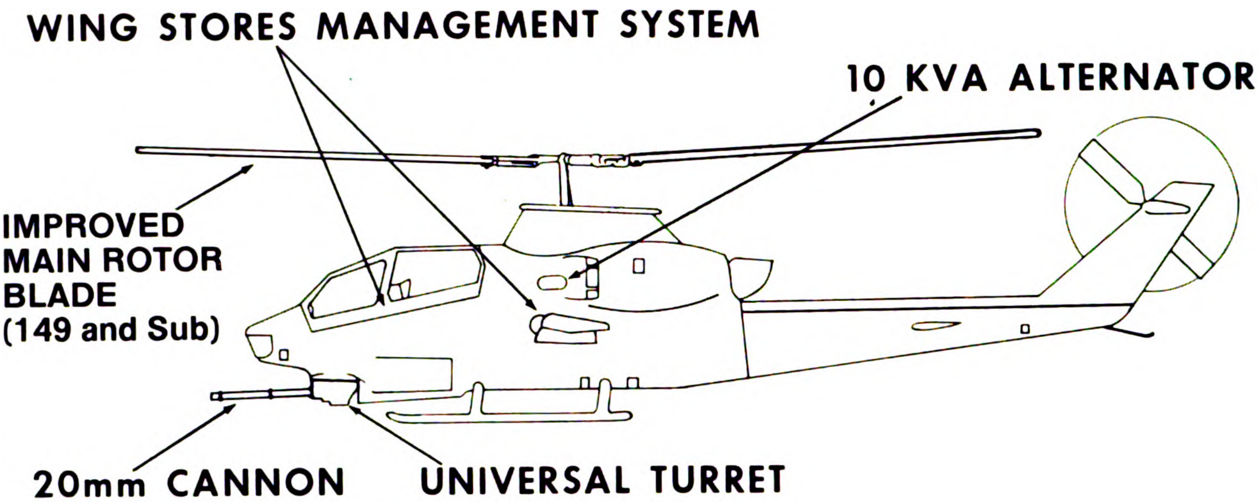


Figure 1—Production upgunned AH-1S features

MODERNIZED COBRA PART II

Colonel Jay W. Pershing

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LAST MONTH part one of this article presented an overview of the AH-1 Modernization Program. It focused on the features of product improvements and how the resultant improvements will be incorporated into the Cobra TOW (tube-launched, optically-tracked, wire-guided missile) antiarmor attack helicopter fleet.

This article addresses, in part, the new weapon subsystems which will increase significantly the combat capability of Cobra TOW attack helicopters.

The requirement to modernize and "upgun" the Cobra was defined by a Special Study Group (SSG) during the Priority Aircraft Subsystem Review at Ft. Rucker, AL from November 1974 to December 1975. (See "Pass in Review," April 75 *DIGEST* and "The Upgun Dilemma," May 75 *DIGEST*.)

The SSG, under the direction of the commanders of the U. S. Army Armor and U. S. Army Aviation Centers, was comprised of representatives of TRADOC (Training and Doctrine Command), DACROM (Army Materiel Development and Readiness Command), subordinate commands, the Cobra Project Manager's Office and field commands. Following affordability analyses of the SSG recommendations by the Department of the Army staff, Required Operational Capability (ROC) documents were approved and used as the basis for structuring the current Cobra Modernization Program.

The first major effort to upgun the Cobra attack helicopter was included in the Enhanced Cobra Armament Program (ECAP). Bell Helicopter Textron (BHT) is the prime contractor and system integrator. The program is divided into two phases to best meet the funding and development time frames.

Phase I includes development and qualification of a universal turret to accommodate either the 20 mm or 30 mm weapon system and a Stores Management/Remote Set Fuzing Subsystem. It also will include aircraft interface aspects and the application of additional fiscal year (FY) 78 product improvement programs (PIPs).

Phase II includes the qualification of a new fire control subsystem, the incorporation of additional PIPs and improvements in aircraft survivability equipment. Phase II will be discussed next month in part 3 of this article. Figure 1 summarizes the basic features of the ECAP Phase I Program.

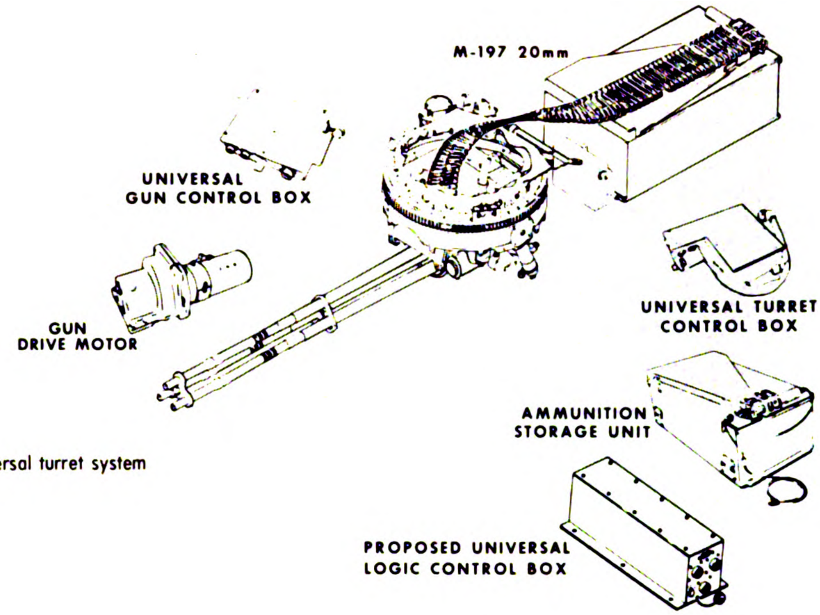


Figure 2— Universal turret system

UNIVERSAL TURRET

The Armament Systems Department of General Electric in Burlington, VT developed and manufactures the universal turrett. The objectives of the Universal Turret Program are to provide an improved standoff capability, improve antipersonnel and antimateriel effectiveness and accommodate either a 20 mm or 30 mm weapon. This new turret eventually will replace the M28 (7.62 mm/40 mm) subsystem now installed in the Cobra.

The 101st new production AH-1S was delivered in September 1978 and was the first to be equipped with the universal turret and the 20 mm, M197 gun. The 30 mm weapon subsystem is still a user requirement, however, final approval for this program has not been obtained. The Universal Turret is electrically powered and has a design weight limit of 175 pounds. The basic components of the system (figure 2) are the turret, linked feed system and three electronics boxes containing the turret, gun and logic controls.

In the AH-1S, the Universal Turret fires through ±110 degrees forward azimuth and has a variable elevation of 20.5 degrees maximum and a depression of 50 degrees maximum. Turret position is controlled by the pilot or copilot through helmet sights or by the copilot through use of the Telescopic Sight Unit (TSU) of the missile subsystem. The turret is electrically driven by two servo motors—one for azimuth and one for elevation. The motors receive position commands from either the TSU or helmet sights and feature quick response and safe, reliable operation.

As previously indicated, the universal turret will accommodate either the 20 mm, M197 Vulcan or a 30 mm weapon. The saddle of the turret is designed to accommodate a 30 mm weapon and the quick release pin mountings of the M197. The ammunition storage container is designed to hold either 20 mm or 30 mm ammunition. Partitions will be added to the container to accommodate the shorter 20 mm round. Ammunition chuting is easily exchanged by using quick release fasteners. The operation of interchanging gun, chuting and feed systems takes less than 30 minutes.

The M197 20 mm gun is shown in figure 3 mounted on the universal turret with its ammunition container. It fires standard M50 series 20 mm ammunition at a rate of 730 ±50 shots-per-minute with an effective range of 2,000 meters. For the AH-1S, the gun is held within the turret by a rear ball mount, a slider, and a low force recoil adapter. The low force recoil adapter reduces the recurring peak recoil load of the gun to about 1,150 pounds.

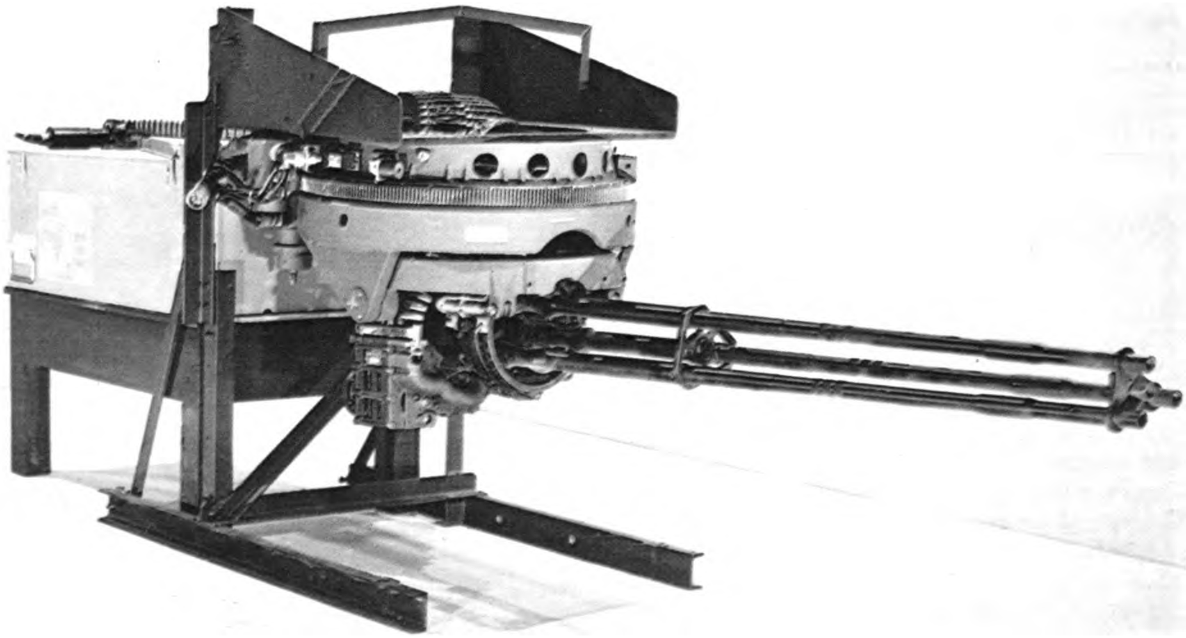
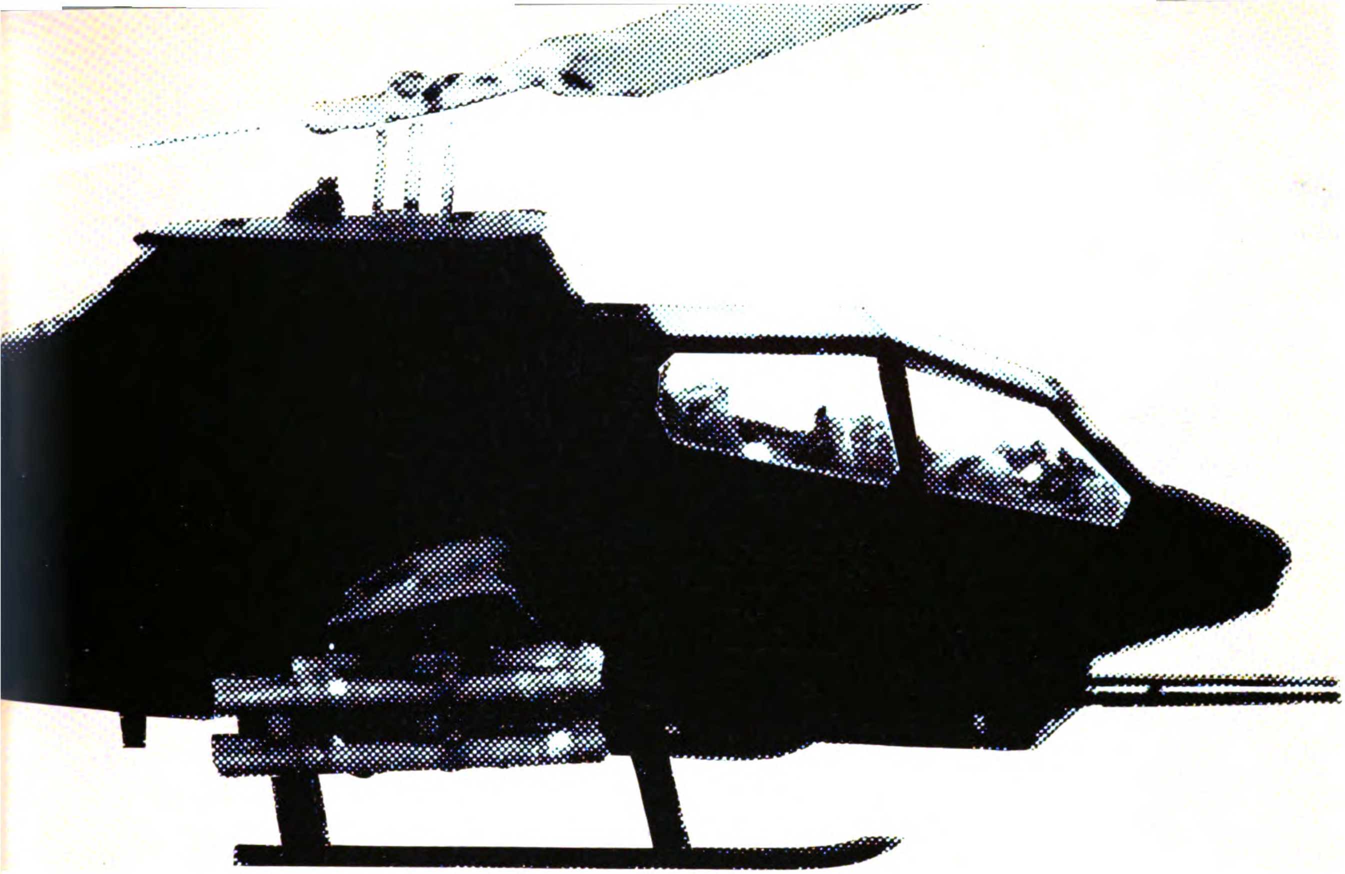


Figure 3—M197, 20 mm gun with ammunition container



TURRET AND CONTROLS

On the AH-1S, the turret is mounted under the nose of the helicopter, the same as the present M28 turret. The turret contains the components necessary for positioning and firing the gun as directed by the gunner from the sighting station. Positioning of the gun is performed by a gimbal and a saddle which moves the gun in azimuth and elevation respectively. The azimuth and elevation drives are powered by direct current motors through gear reductions. Electrical current for the motors is controlled from the servo amplifiers, located in the turret control box, which use the helicopter's 28 volt DC (direct current) power source.

The turret, gun and universal logic control boxes provide the electronics for all controls and switches in the system.

20 MM LINKED STORAGE AND FEED SYSTEM

A complement of 750 20 mm rounds of linked ammunition is fed to the gun through flexible chuting from the ammunition box stored in the ammunition compartment of the helicopter. During firing, a small booster motor pulls linked ammunition from the box and pushes it into a section of flexible chuting which is connected to the gun's feeder. The booster eliminates excessive belt pull loads, which occur when the belt is pulled on by the delinking feeder, and eliminates the requirement to manually fill the chute during loading.

2.75 INCH ROCKETS

The 2.75 inch rocket subsystem has been one of the primary aerial weapon systems used on the Cobra. It provided valuable support to ground units during the Vietnam conflict.

There are several development programs that have been initiated by the 2.75 Inch Rocket Project Manager to improve the warheads and launchers to be used on the modernized Cobra. The basic 2.75 inch rocket motor and the available warheads are shown in figure 4. The submunitions and chaff warheads are the newest developments in the warhead program.

During the SSG review in 1974-5, the weight of any prospective improvement was a key consideration in structuring the modernized Cobra program. As a result of the weight factor, a requirement for lightweight 7 and 19 round launcher development was established. The design features of these launchers are illustrated in figures 5 and 6.

The Stores Management/Remote Set Fuzing Subsystem developed and manufactured by Baldwin Electronics Incorporated, Little Rock, AR, will use the 2.75 inch warhead and launcher improvements to enable more effective mission accomplishment by Cobra crews. To date provisions only have been provided for this subsystem on the new production aircraft. It is scheduled to be installed on the 199th new production modernized AH-1S to be delivered in November 1979.

The control panel for the stores management/remote set fuzing subsystem is shown in figure 7. The panel will provide the means to select and fire, while in flight, any one of five types of external rocket stores. It will allow the pilot to set range and select the fuze setting best suited to the type target being engaged to include settings which will permit penetration of tree canopies or fortifications protecting selected targets.

Although electrical power requirements for the AH-1S continue to increase, adequate power will be available to operate subsystem changes described in this article, plus several high electric power demand devices forthcoming.

Beginning in September 1978, modifications include the installation of alternating current alternators on the transmissions of all Cobra S models produced.

The weapon subsystems discussed above, coupled with the TOW missile, and the versatility of available ordnance will provide Cobra crews with the required firepower to accomplish missions of antiarmor, direct aerial fire support and armed escort/reconnaissance. The commonality of guns, rockets and missiles will enhance the effectiveness of rearming at forward area rearm and refuel points (FARRPs). The survivability of the crews will be improved greatly with the added standoff capability; the accuracy and effectiveness of the new weapons and ammunition; plus the capability to remotely select the correct fuze setting for the type target being engaged. The enhanced armament subsystems on the modernized AH-1S will keep the attack helicopter a viable member of the Army's combined arms team for many years.

Next month part 3 of the "Modernized Cobra" will cover the fire control, aircraft survivability equipment, laser rangefinder, and the laser tracker programs.

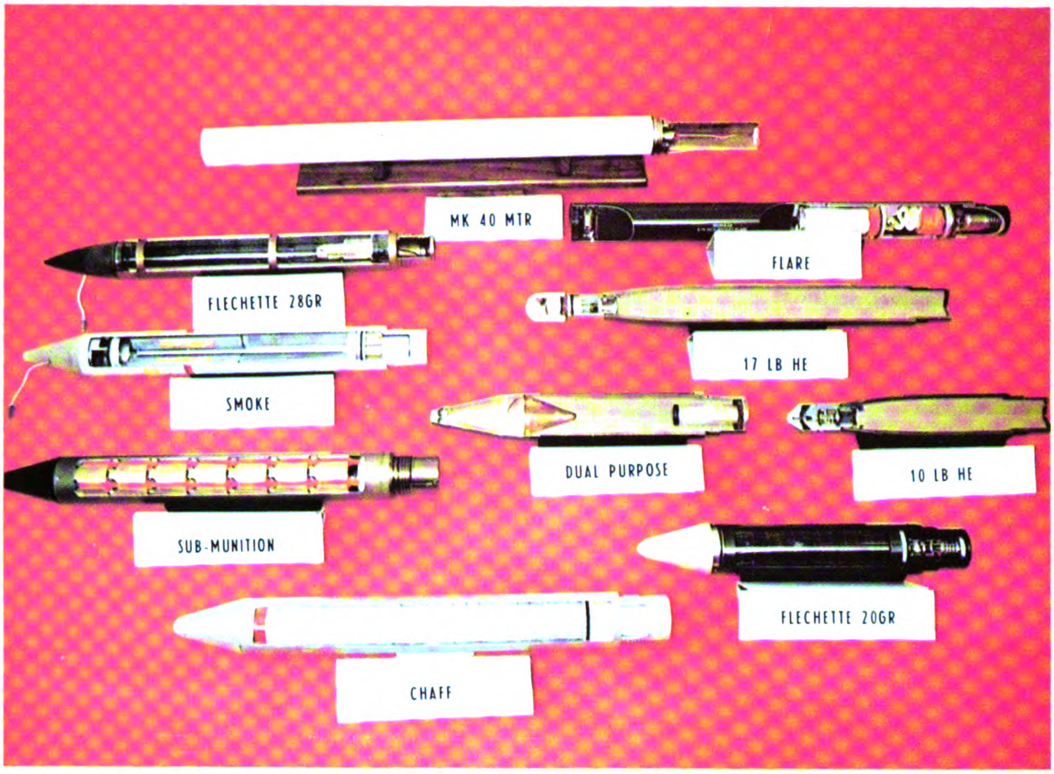


Figure 4—2.75 inch rocket motor and warheads

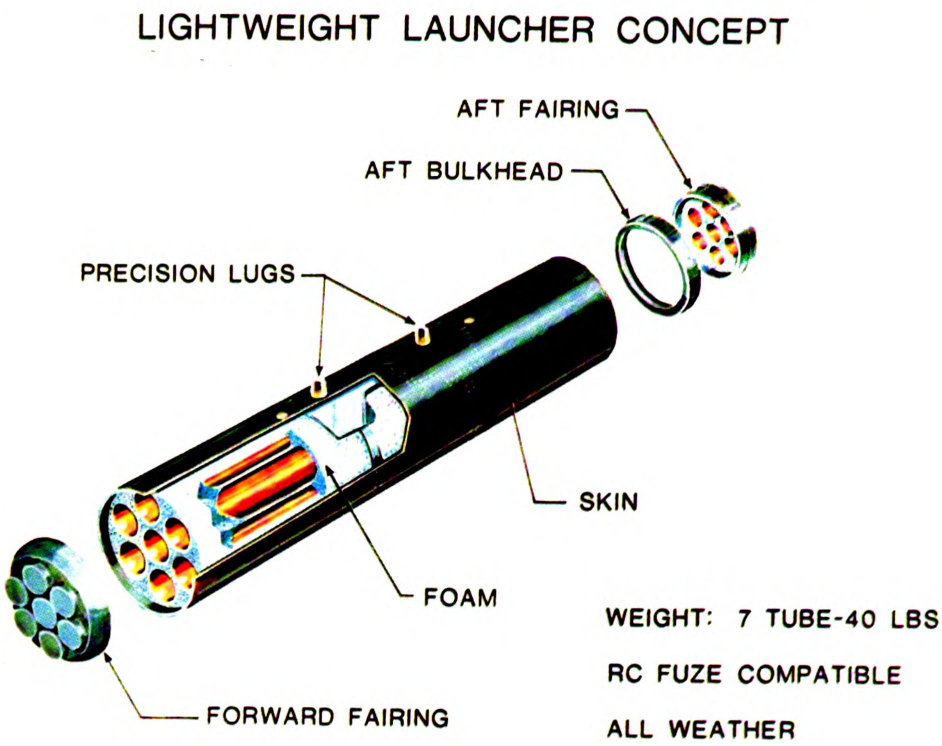


Figure 5—7 round 2.75 inch rocket lightweight launcher

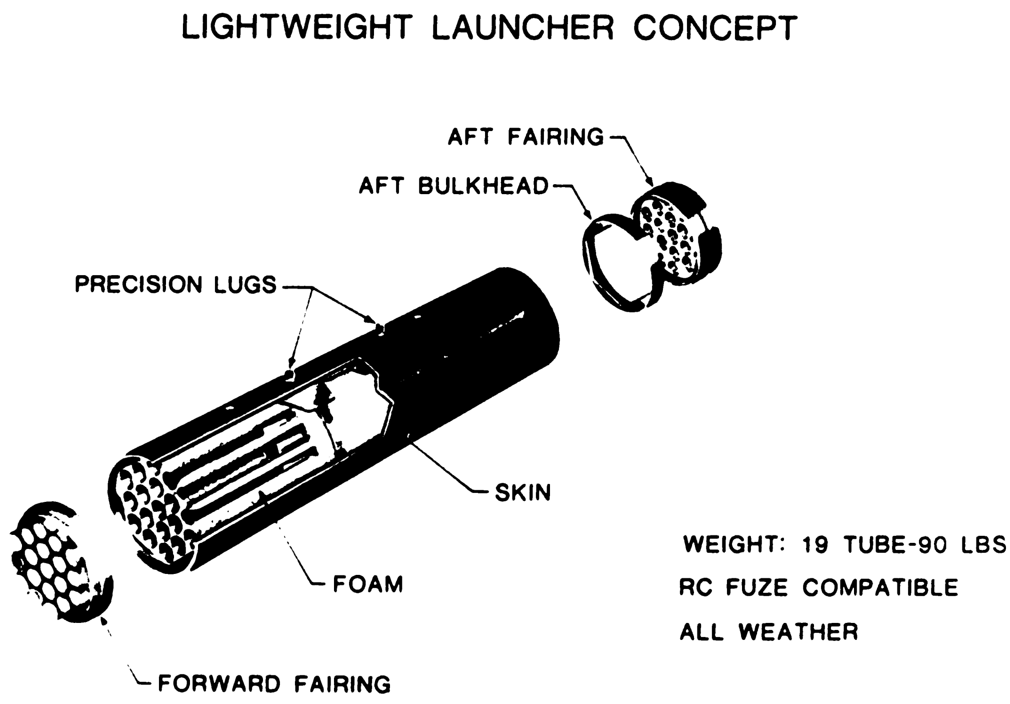


Figure 6— 19 round 2.75 inch rocket lightweight launcher

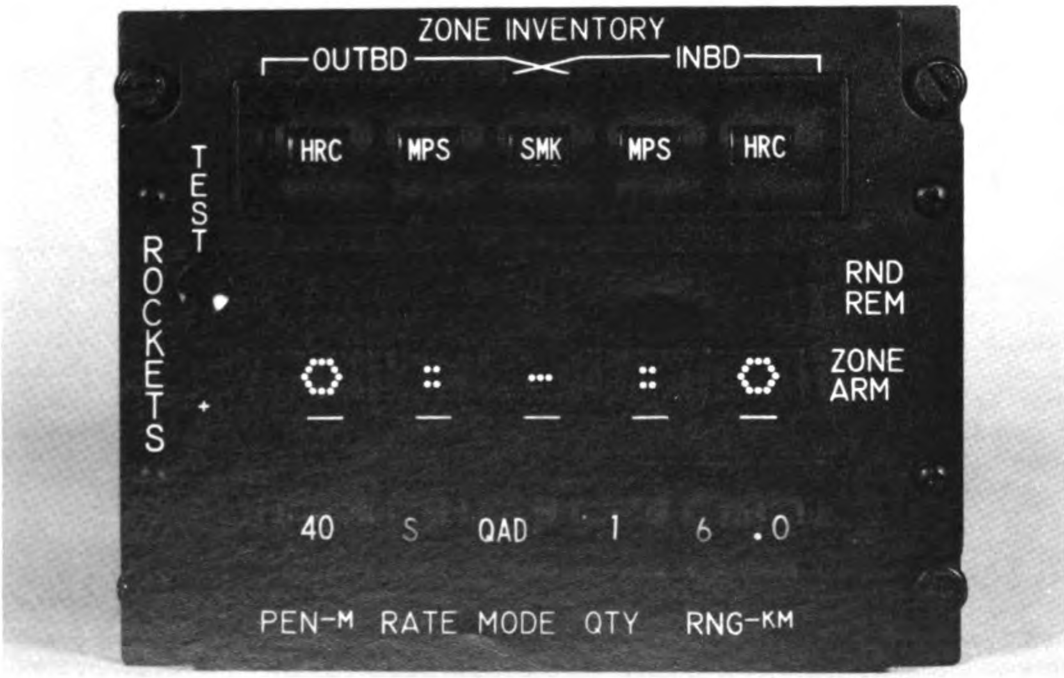


Figure 7– Control panel for stores management and remote fuzing subsystem

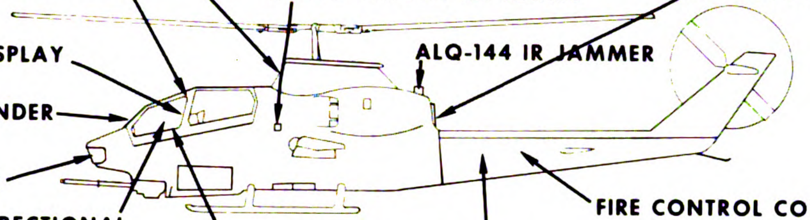


Figure 1 — Modernized AH-1S (199 -297)

MODERNIZED COBRA PART III

Colonel Jay W. Pershing
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St. Louis, MO

DURING THE TWO previous series on the modernized Cobra, an overview of the total program and the weapons program have been presented. This article will address the fire control, airborne laser tracker and aircraft survivability equipment programs.

FIRE CONTROL

The fire control subsystem is the major effort of Phase II of the Enhanced Cobra Armament Program (ECAP) designed to upgun and modernize the Cobra attack helicopter. The featues of the new fire control subsystem include a pilot heads-up-display (HUD), fire control computer (FCC), air data subsystem (ADS) and laser rangefinder (LRF). The new fire control is scheduled to be installed on the aircraft to be delivered in November 1979.

Figure 1 shows the configuration changes for the 199th through 297th AH-1S aircraft which will complete the modernization of the Cobra TOW (tube-launched, optically-tracked, wire-guided) attack helicopter.

The HUD, being developed by Kaiser Electronics in Palo Alto, CA, will provide increased weapon delivery capability for both day and night operation. The primary purpose of the HUD is for aiming the aircraft to fire the TOW missile system and other aircraft weapons. It will aid the pilot in navigation and increase flight safety during nap-of-the-earth (NOE) flight. The HUD consists of two line replaceable units, a pilot's display unit and a symbol processor unit (SPU).

The pilot's display unit, shown in figure 2, is mounted on the pilot's instrument panel and presents flight, target acquisition, and weapon delivery information using a cathode ray tube (CRT)/optical display. All of the HUD symbology appears in the pilot's normal field of view.

Weapons systems, fire control, flight status and flight control information are displayed, including target acquisition reticles, aircraft boresight reference, and gunner's sighting cues. The fire control data displayed includes aiming and firing data for rockets, guns and TOW missiles and is based upon the weapon type selected by the crew. Also displayed are engine torque, radar altitude, magnetic heading and target range data information. Examples of this symbology are shown in figure 3.

The SPU, which receives and processes inputs from the fire control computer and other aircraft sensors and generates all of the symbology which is displayed on the HUD, is a compact, lightweight electronic unit which is mounted in the aft aircraft equipment compartment.

The fire control computer is being developed by Teledyne Systems Company in Northridge, CA and will provide the gunnery solutions for the turret and rocket weapon systems. It is a general purpose, digital computer which accepts inputs from the universal turret, air data subsystem, laser rangefinder, airborne laser tracker and telescopic sight unit and performs computations that enable the pilot and copilot to deliver accurately ordnance from the turret and rocket weapon systems. Figure 4 shows the computer which will be located in the aft fuselage compartment.

The air data subsystem is being developed by Marconi-Elliott Avionics in Rochester,

England and provides three dimension airspeed, downwash, static pressure and air temperature information to be used by the fire control computer to solve the gunnery problem for increased accuracy of the turret and rocket weapons. The swiveling pitot static probe shown in figure 5 is mounted on the top of the canopy extending out to the right side of the aircraft and is used to gather the data to be sent to the fire control computer.

The primary purpose for the addition of the laser rangefinder into the TOW Telescopic Sight Unit (TSU) is to enhance the ballistic weapons accuracy on the modernized Cobra and increase survivability from enemy fire by allowing the AH-1S to stand off to the maximum range of the TOW missile.

This program is an integration of an existing laser design which has been used in other Army laser systems such as the ground lightweight laser designator (GLLD), XM-1 tank fire control and the Army lightweight target designator (LTD). The TSU provides gunner aiming line of sight angles, rates and laser range to the fire control computer. Other inputs from the data computer and vertical gyro will be used by the fire control computer to compute the weapon lead angles required to minimize the aiming error.

Maintenance features include a laser built-in-test (BIT) which can be performed on the ground with the TSU window cover installed. Since the LRF fault isolation can be performed by BIT at aviation intermediate maintenance (AVUM) and aviation unit maintenance (AVIM), no changes are required to the M65 Test Set, Guided Missile System (TSGMS). Laser malfunctions will require replacement of the TSU.

The LRF can be a hazardous

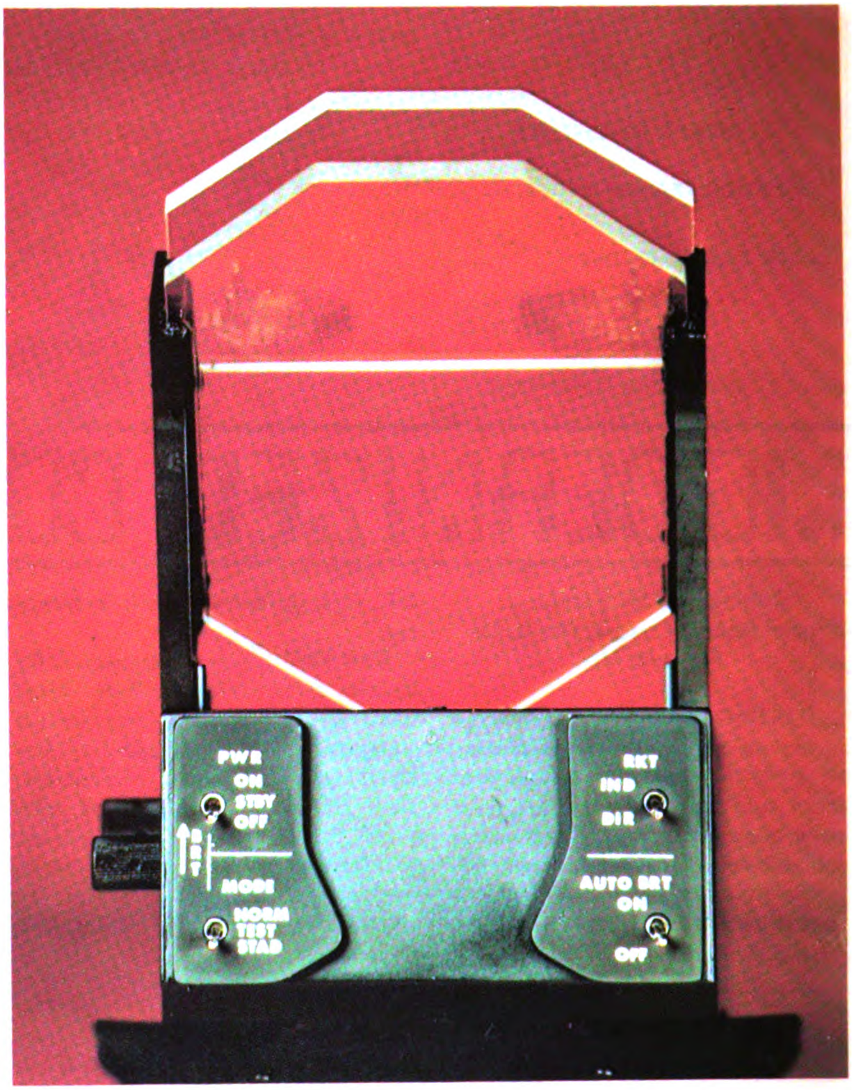
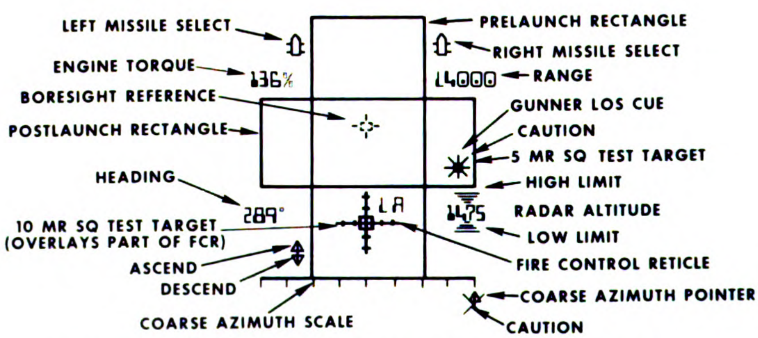


Figure 2 — Pilot's Display Unit



(FIRING/ENGAGEMENT symbology varies from this test pattern)

Figure 3 — HUD Test Mode Symbology

device if used indiscriminately on the ground or in the air. Safety features are included to minimize probability of injury to the aircraft crew and ground support maintenance personnel. As an example, the laser cannot be fired when the aircraft engine is not running and when the protective cover is not installed on the TSU window. However, when the protective cover is placed over the TSU window the laser can be fired to perform BIT. When airborne, the laser cannot be fired unless the TSU laser eye filter is switched in place and the laser is armed by both the pilot and the gunner. Figure 6 shows how the laser rangefinder will be installed in the M65 TSU, which will be accomplished by Hughes Aircraft Company.

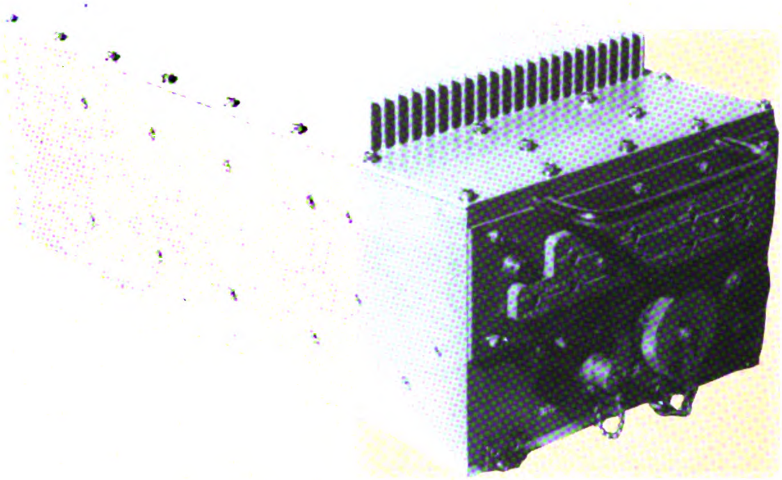


Figure 4—Fire Control Ballistics Computer

AIRBORNE LASER TRACKER

The Airborne Laser Tracker (ALT) AN/AAS-32 is an aircraft mounted system designed to automatically search, acquire and track target reflected laser energy. The system was developed in conjunction with the laser target designator AN/PAG-1 (hand held) but is compatible with any laser designator of the same wavelength that employs the Tri-Service pulse repetition frequency (PRF) coding scheme. The AN/AAS-32 major components are shown in figure 7. The ALT will improve target acquisition and provide target hand-off capability for laser designated targets. Provisions only will be accomplished for this system on the aircraft scheduled for delivery in November 1979. A decision to defer installation of the ALT has been coordinated with the commanding generals of the Aviation Center and the Armor Center. It is estimated to be installed in fiscal year 1983.

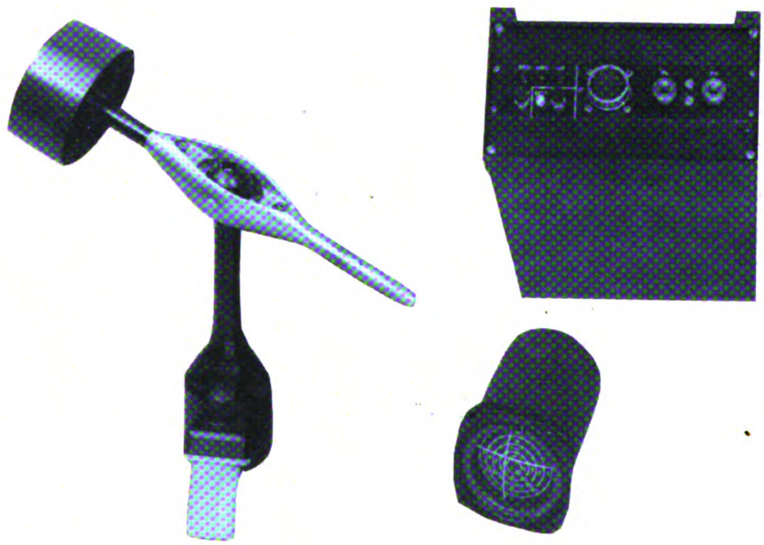


Figure 5—Air Data Subsystem Components

AIRCRAFT SURVIVABILITY EQUIPMENT

The Cobra aircraft is one of the most important aircraft survivability equipment (ASE) customers of the present fleet of front line aircraft. In fact, since 1974 intensive programs in infrared (IR), optics, radar, and ballistics survivability have been underway to counter present and projected air defense threats. The results are now evident in the new look of the Cobra weapons platform. The IR suppressors and low reflectance IR paint, flat plate canopy, warning receiver antennae and jammers

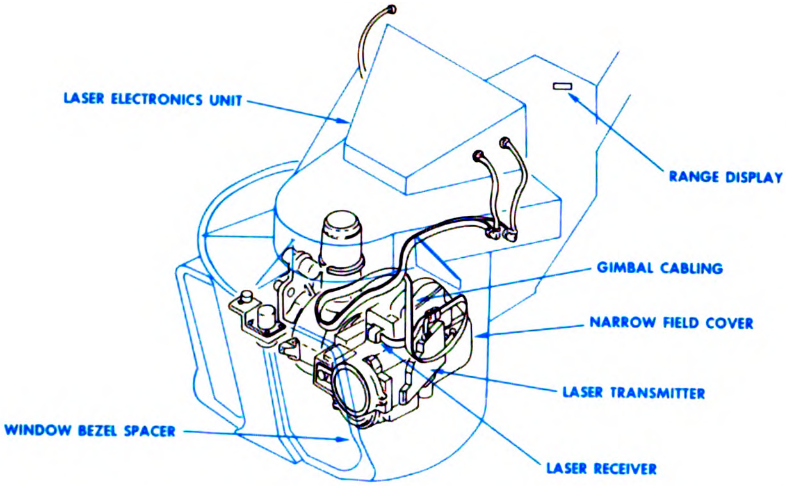


Figure 6—Laser Rangefinder Installation

will complement the advanced weapons, fire control and navigation developments to transfigure the lean AH-1G to the higher powered modernized and survivable AH-1S.

In addition to these hardware improvements, tactics and doctrine have been developed to take advantage of the new weapons capability which will enhance the aviator's ability to survive in combat. Testing and improving of these tactics and doctrine during field exercises has established the credibility that Army helicopters can survive and operate effectively on the modern battlefield.

Infrared Survivability. IR suppressors and paint are used to reduce the AH-1S signature sufficiently to operate against the less sophisticated missiles. During 1976 and early 1977, the bell scoop IR suppressors and IR paint were applied to the Cobra/TOW helicopters in Europe, Continental United States, Hawaii and Korea. The scoop weighs 40 to 45 pounds and shields the hot metal parts from view of the IR missile. IR paint has been adapted as the standard Army paint and is being applied routinely on production, overhaul and modification lines. For advanced threats, an improved IR suppressor, which reduces hot metal plus plume (HM+P) signature is required. It reduces the effective range of the more sophisticated IR missiles and makes it feasible to employ an efficient IR jammer.

The AH-1S suppressor program is now in the latter stages of engineering development and scheduled for production in 1979. It is a cooled plug-type suppressor and the design uses large volumes of ambient air to cool the exposed metal surfaces and to dilute the exhaust gas to lower the plume signature. Figure 8 shows the present bell scoop IR suppressor. Figures 9 and 10 show the new hot metal plus prime IR suppressor.

ALQ-144 IR Jammer. The IR jammer is required to defeat the postulated air defense growth threat. The ALQ-144 weighs 25 to 30 pounds and is an active IR countermeasure which confuses the threat IR missile. Development and operational testing has been completed successfully and production is planned for 1979. The application of the ALQ-144 to the AH-1S will be accomplished along with the new hot metal plus plume suppressor.

RADAR SURVIVABILITY

The AN/APR-39 radar warning receiver (RWR) on the Cobra is a simple lightweight system consisting of five antennas, two receivers, a comparator and a cathode ray display and weighs about 10 pounds. For low level and NOE operations, the radar signal density will be low due to terrain masking, permitting the use of this proven system. The APR-39 provides the pilot with the advantage of being able to take evasive maneuvers before actually receiving fire from radar-directed weapons. The warning is provided to the pilot through an audio tone in the headset and a strobe on the cathode ray tube.

A laser warning receiver, adaptable to the APR-39, is now completing advanced development and is scheduled to enter full-scale engineering development in early fiscal year (FY) 79. It weighs about eight pounds and will display quadrant warning to the pilot that a laser designator or rangefinder is aimed at the aircraft.

The ALQ-136 radar jammer on the Cobra is an automatic radar jammer for attack helicopter use that is passive until illuminated by a threat radar which has locked onto the aircraft. The ALQ-136 automatically causes a breaklock on the threat radar, then returns to the passive mode. It can defeat two threats simultaneously. It is scheduled to be applied to the AH-1S in 1979. The M-130 chaff dispenser is the low cost radar countermeasure solution for the Cobra, pending availability of the ALQ-136 radar jammer. This system has proven its effectiveness, weighs about 30 pounds fully loaded with chaff cartridges and is in production. Provisions for the Cobra weigh 2 to 3 pounds.

OPTICAL SURVIVABILITY

Canopy glint, rotor blades and fuselage color were determined to be major contributions to the visual detection of NOE helicopters. All new production AH-1S have flat canopies and all other Cobras will receive the new canopy during future S model conversion programs. After extensive field testing it was determined that the dark green IR paint on the fuselage and flat black on blades was the optimum paint scheme for Central Europe and Asian theatres. This is now standard paint as described in the IR suppression discussion, above.

Figure 7—Airborne Laser Tracker AN-AAS-32

BALLISTICS SURVIVABILITY

The AH-1S already has benefitted from vulnerability reduction or ballistics hardening efforts. The new AH-1S tailbooms have been designed to withstand ballistics damage from a 23 millimeter (mm) round. The improved tailbooms will be applied to all conversion Cobra aircraft. The new main rotor blade not only reduces the radar cross section but can withstand a 23 mm round ballistic damage and continue to fly. A new transmission is under development which will be capable of operating for 20 minutes without lubrication should it receive a ballistic hit.

The Cobra has the best aircraft survivability equipment presently available and active programs to meet the growth threat are being expedited and matched with the aircraft production to minimize cost and modification downtime. The new survivability equipment is being developed for ease of installation through kit design which provides the commander the flexibility to use only the ASE that is needed.

Figure 8—AH-1 with Bell IR Suppressor

Figure 9—Modernized AH-1S with hot metal plus plume IR Suppressor

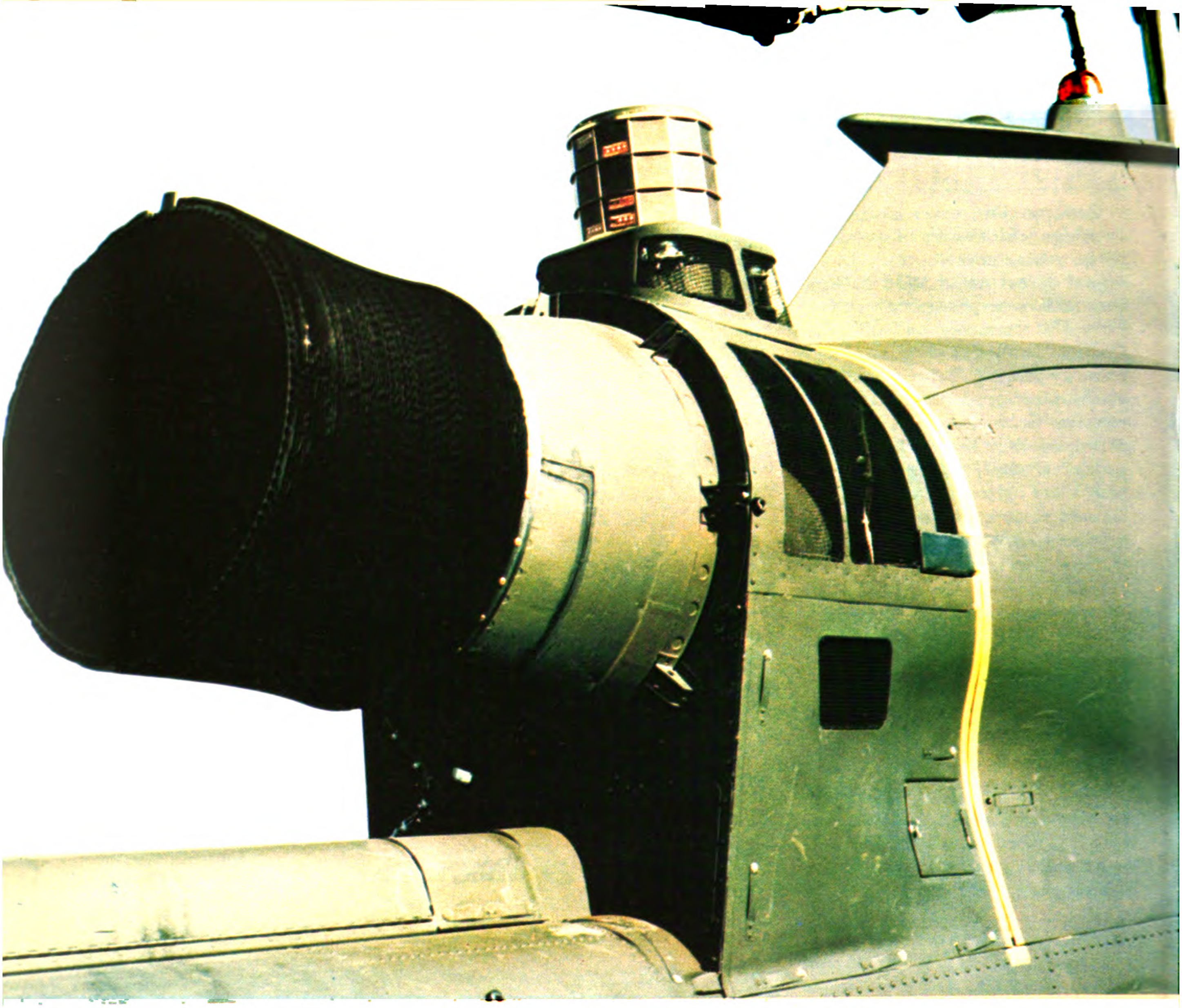


Figure 10—Hot Metal plus plume IR Suppressor and IR Jammer

TECHNOLOGICAL ADVANCES

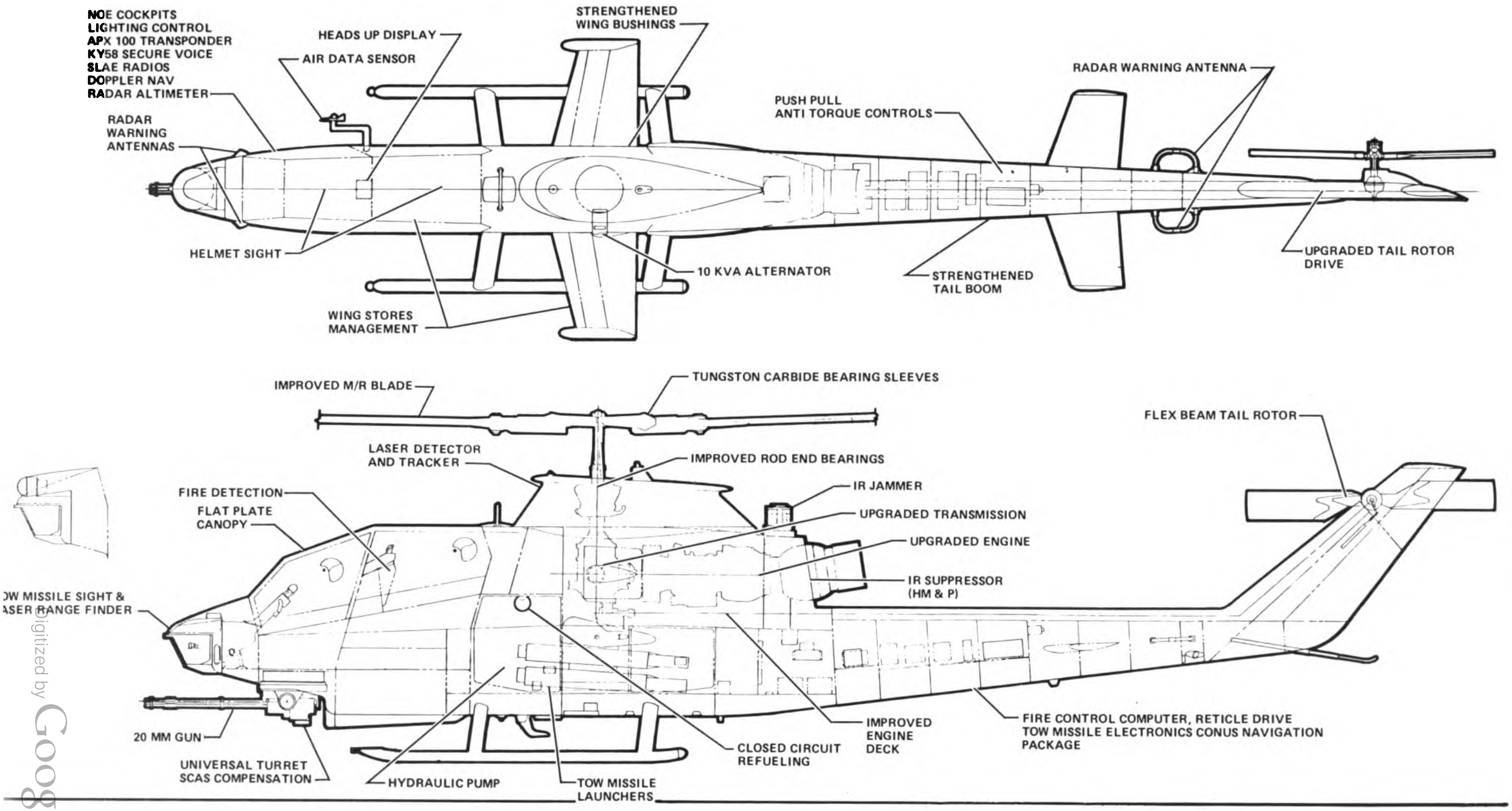
There are several technological improvements being developed which could enhance the AH-1S Cobra TOW navigation, target acquisition and communication capabilities.

A projected map display (PMD) for navigation, a FLIR augmented TOW Sight (FACTS) for high threat acquisition and recognition and a new group of NOE radios for communication with all battlefield elements are possible candidates for additions to the Cobra.

Also, an integrated avionics control system (IACS) which will provide for complete avionics, doppler navigation control and PMD interface. Efforts are underway to uprate the T53-L-703 engine from its present 1,800 shaft horsepower (SHP) to 2,000 SHP to meet the 4,000/95 degrees fahrenheit (F.) hover out of ground effect at max gross weight requirement.

A multiplex system is being investigated which will eliminate more than 100 pounds of wire bundle weight. These new candidates will increase reliability, save cockpit space, reduce pilot workloads and increase the efficiency of the overall Cobra weapon system.

These three articles have provided a look at the programs and type of equipment to be utilized to completely modernize the AH-1S Cobra TOW to meet the needs of the Army through the 1980s and 1990s.



MODERNIZED COBRA